September 2018

# Australia's IoT Opportunity: Driving Future Growth

An ACS Report

Prepared by PwC

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“We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten. Don’t let yourself be lulled into inaction.”

– Bill Gates

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# Foreword by ACS

**Yohan Ramasundara**
President, ACS

**Andrew Johnson**
Chief Executive Officer, ACS

Forecasts widely vary on worldwide connected IoT devices by 2020; anywhere from 50 billion to 200 billion. When you think of information systems capturing data and communicating to other information systems, the opportunities are breathtaking.

As one example, in the 2017 edition of Australia's Digital Pulse, we highlighted the burgeoning 'smart agriculture' industry that promises to improve output and efficiency through the use of smart sensors and intelligent control systems. By 2050, the average farm will produce 4.1 million data points per day thanks to IoT, and this data will be processed in real time to improve yields, make better predictions and reduce costs.

Today, we regularly hear the catch cry that data is the new fuel for the digital economy. It is, however, still crude oil, and we as a nation need to decide how best to refine it and leverage it.

In undertaking this report, we wanted to be pragmatic, to assess the current landscape in Australia and identify the levers that could deliver exponential economic growth. Not sensor proliferation for the sake of showcasing connectivity and amassing seas of data; rather identify real world problems that Australia could solve and take to the rest of the world. We wanted to identify those areas where we as a nation could be a leader – as a fast follower approach simply results in importing solutions as opposed to exporting them.

ACS has a vision for Australia to be a world leader in technology talent, fostering innovation and creating new forms of value. We are firmly vested in the innovative creation and adoption of best of breed technology in Australia.

Being a leader in niche areas has natural flow-on effects across the economy. Doubling down on IoT will allow our citizens to develop the skills and take advantage of the opportunities presented by the fourth industrial revolution, including attracting higher paying jobs.

The fourth industrial revolution and IoT promises new employment opportunities in the technology sector, especially in areas such as data scientists, software and systems engineers, full stack developers, cyber security professionals, and communications and network designers.

We feel confident that the levers recommended in this report will provide a bright future for Australian industries and underpin continued high living standards for our nation in the coming years.

# Foreword by PwC Strategy&

**Dominik Baumeister**
Partner, Strategy&

Australia's economic performance over the last quarter of a century has been nothing short of remarkable. However, while the nation should feel rightly proud of its achievements – including the building of world-class industries in mining, agriculture and healthcare, for example – it cannot afford to rest on its laurels. A good deal of Australia's prosperity has, in fact, been due to dynamics outside its control, such as record demand for resources and subsequently high commodity prices.

Unfortunately, a key factor that has been under its control, namely the productivity of its industries and workforces, has been something of an Achilles heel for Australia. So much so, that productivity growth is now consistently less than half of what Treasury has determined is required for the nation's continued prosperity.

The 'Internet of Things' represents a set of technologies that can help Australia address its productivity challenge. In many industries, particularly those that are dominated by physical activity, the IoT can significantly increase productivity. Our report has quantified, for the first time, the potential economic benefit to Australia as a result of broad uptake of IoT technology in five industries that have the most to gain: construction, mining, healthcare, agriculture and manufacturing.

In these industries, Australia has the chance to leapfrog the productivity gap through the intelligent use of the IoT. Given that a great deal of IoT technology is relatively new, many of the specific opportunities are still to be uncovered, and for some sectors, it could be a chance to undergo a radical transformation and make a fresh start.

However, Australia cannot assume that this window of opportunity will remain open indefinitely. In fact, there is a global race to establish dominance in the IoT – both in the hardware and software that make up the IoT ecosystem and in the application of the technology to improve business models and increase competitiveness. The global value of the IoT is estimated to be $A5–6 trillion by 2030. The question for Australia is how much of this benefit will it capture for itself? Conversely, will it do nothing and risk falling further behind its peers?

Our report sets out a number of straightforward recommendations for both business and government to make sure that Australia takes advantage of the IoT opportunity. If adopted, these actions would not only add hundreds of millions to GDP, boost productivity and make the nation's exports significantly more competitive, but also help make individual businesses more competitive and 'future-fit'. It's time for Australia to step up its game and establish its place in the Internet of Things.

# Executive Summary

Australia has benefited and prospered from an unprecedented 27 years of economic growth. However, economists argue our good fortune is mainly due to external factors rather than through improvements in the productivity of our industries or workforce. Weak productivity growth is costing the economy dearly and could make Australia uncompetitive in global markets critical for our future. Modelling by PwC, which focuses on the fundamental drivers of economic growth – demographics and productivity – suggests that Australia could slip out of the G20, to 23rd spot in terms of GDP (PPP), by 2030.[1]

The Internet of Things (IoT) provides Australia with an opportunity to address this downward trajectory. If adopted at scale, it could significantly improve the productivity of several of the nation's key industries and in doing so deliver substantial benefits to the whole economy. If, on the other hand, Australia fails to leverage this technology efficiently and effectively, the country risks a significant reduction in global competitiveness.

This study, a first of its kind in Australia, takes a broad economic and business view of the IoT opportunity. It assesses the revenue and cost implications of the technology on the industries most likely to benefit from it: construction, mining, manufacturing, healthcare and agriculture. It also considers the opportunities for developing the IoT industry (as a subset of the broader ICT sector) in Australia and looks at the cyber security risks associated with increased uptake of IoT technology.

## Key Findings

Across the five industries assessed, which represent 25% of Australia's GDP, **the IoT can achieve potential annual benefits of A$194–308 bn** over a period of 8–18 years. This impact translates into **average productivity improvements of around 2% p.a.** across these industries.

### Construction

Total potential annual run rate benefits = A$75–96 bn

Construction has been one of the slowest industries to adopt process innovations, yet it is characterised by physical activities and a significant amount of technical equipment. The combination of these two factors makes for substantial potential benefits from the IoT.

### Manufacturing

Total potential annual run rate benefits = A$50–88 bn

The stable and controlled setting in which manufacturing typically operates combined with the large number of 'things', such as machines and sensors, creates an ideal environment for the IoT.

### Healthcare

Total potential annual run rate benefits = $A34–68 bn

While other industries have reinvented their delivery models, technology base and value chain, healthcare in Australia remains relatively unchanged and is becoming increasingly unsustainable. The potential impact of the IoT on the broader healthcare sector is enormous.

### Mining

Total potential annual run rate benefits = $A22–34 bn

The IoT has significant potential to increase output, decrease production costs, improve safety outcomes and reduce environmental impact. The benefits delivered by the IoT would have substantial flow-on effects given the importance of mining to the Australian economy.

### Agriculture, Fishing and Forestry

Total potential annual run rate benefits = $A14–22 bn

Adopting IoT technology would help primary producers increase yields and reduce costs, which in turn would lift profitability and improve the competitiveness of Australian produce in international markets.

## Growing a Stronger Australian IoT Industry

The value of the IoT industry in Australia, which includes hardware, sensors, backbone capacity, network capability, apps and solution services, is already worth close to A$19 bn. However, unlike the overall ICT market, which is growing only slightly faster than GDP, IoT-related products and services are increasing at a significant 14% compound annual growth rate (CAGR), and are expected to reach close to A$30 bn in five years' time.

While the IoT industry globally is dominated by multinational heavyweights, such as Amazon, Google, Microsoft, Siemens and GE, this study identified significant opportunities for Australia to develop its domestic industry further. These opportunities include carving a niche in specific core elements of the IoT ecosystem by:

- Maintaining control of the domestic communications and networking space
- Becoming a global leader in identity and security
- Becoming a global leader in selected applications
- Capturing the value of localised solution services, and enhancing quality and applicability in the domestic market.

Across the other elements of the IoT ecosystem, namely hardware, backbone and platforms, Australia needs to ensure that we remain rapid followers in the adoption of overseas-developed solutions. The exception may be development of specific IoT hardware that supports industries where Australia has expertise (e.g. agriculture, healthcare) or global scale (e.g. mining).

## Managing and Leveraging Cyber Security

While the IoT will deliver significant benefits to both people and the economy, it also introduces new cyber security risks. Both business and government have a role to play to control and mitigate these risks.

Organisations need to set a cyber security strategy and take action via active and ongoing control processes, procedures, automation and protection. The strategy should be based on the following principles:

- Holistic system-wide risk approach
- Balance innovation and risk
- Data governance
- Favour a loosely coupled architecture
- Identity and access management
- Password management
- Security testing
- Security monitoring
- Network segregation
- Configuration and patch management

More broadly, there is an opportunity for Australia to use cyber security to advance the nation's IoT agenda. This approach involves taking advantage of the current positive momentum around cyber security to identify areas that will enable further growth across public and private sectors and improve national security. There are also opportunities to create jobs, revenue and a more secure environment through collaboration, education, and the creation of services to address new risks introduced by the IoT.

## Recommendations

The impact of the IoT is broad and further broadening; Australian governments, businesses, and consumers are all affected. As a result, many stakeholders have a role to play in making sure that Australia makes the most of the IoT opportunity and manages the risks involved. To help guide high-level decision-making we highlight a set of key recommendations for leaders in both the public and private sectors that, if implemented, will accelerate the adoption of the IoT in Australia, significantly improve productivity in several critical industries, benefit the individual businesses that implement the respective solutions and improve the competitiveness of Australia's exports significantly.

## Private Sector: Boards and C-suite

1. **Adopt a portfolio investor's mindset: The returns will come in time**

   Technological change is happening at ever-increasing speed, creating immense pressure on organisations to lead with innovation, or at a minimum, adapt 'fast enough'. Businesses should adopt a portfolio investor's mindset towards the IoT and optimise the resources invested: focus on a few specific business opportunities within a portfolio of opportunities and take advantage of the variety of vehicles available to fund and incubate new opportunities.

2. **Assemble a business-led, multidisciplinary team with a clear mandate**

   Any innovation needs to drive the organisation's purpose, strategy and, ultimately, commercial outcomes. While IoT solutions are often technical in nature, they exist to solve business problems and their design and implementation, therefore, need to be business-led and supported by a multidisciplinary team in which members can work together in agile ways.

3. **Establish a data strategy: An immediate 'no-regrets' move**

   Data is the underlying currency of the IoT, and most solutions become more powerful the more data is available. Every organisation should immediately and comprehensively capture and store any data available – a 'no-regrets' move and a necessity for competition in today's digital world – and draft a holistic data strategy. They should also ensure that they maintain consumer and public trust by providing greater transparency and choice around how data is used and by actively considering whether potential data uses are in line with stakeholder expectations.

4. **Design an IoT innovation framework: 'Fail fast', but not randomly**

   Based on a strong corporate strategy, organisations should develop a highly flexible and agile IoT strategy that can quickly adjust to new circumstances. Traditional innovation management approaches are more important than ever, and organisations should design and implement a clear IoT innovation process that runs through the stages of idea generation, business case development, prioritisation, proof of concept, incubation and implementation.

5. **Support the broader Australian IoT development**

   In an environment of ever-faster change, few if any companies can drive IoT solutions alone. To allow Australia to establish a competitive IoT environment to the benefit of all stakeholders, the private sector should support industry- and technology-wide standardisation activities, and collaborate in trying, testing and learning activities.

## Government: Elected Leaders and Policymakers

1. **Create a strong IoT strategy: Through multidisciplinary engagement**

   To ensure both Australia's limited resources and its key comparative advantages as a nation are leveraged in the most optimal way, the country urgently requires a holistic national IoT strategy that clearly articulates plans to achieve rapid adoption of the IoT as quickly and as broadly as possible. This strategy can then be used to align all relevant stakeholders and help identify gaps and ways to address those gaps. It would also help align the support of industry incumbents as well as IoT solutions providers.

2. **Create government demand**

   For industries where the government is the key client, it needs to get in the driver's seat and generate a holistic and detailed framework and strategy for IoT adoption that may include mandatory application of IoT solutions. Most likely this will need to be a multi-level approach from federal, state and local governments so that the requirements are clear and coordinated. It should include, for example, a data and IoT strategy for each new government asset to be built, be it a new rail project or the major upgrade of a hospital. For relevant assets of critical importance for IoT development, those plans should be mandated.

3. **Address structural industry challenges to IoT adoption**

   Where unfavourable industry structures, incentive mechanisms or fragmentation may be preventing or slowing IoT adoption, governments may need to mandate the use of specific elements of the technology, adjust incentive structures, support representative industry bodies in coordinating roles, or provide early stage funding or tax breaks.

4. **Ensure IoT enablement**

   While government needs to play a direct and active role in setting the IoT strategy for the nation, in driving IoT demand where it is a significant customer, and in overcoming specific structural challenges in selected industries, it also needs to play an enabling role across a number of complex dimensions for the IoT. These include: driving R&D funding; ensuring strong collaboration between industry and research institutions; driving high-quality data network coverage; attracting and retaining IoT-relevant talent; ensuring cyber security; and developing safe data sharing protocols and frameworks to safeguard citizen privacy and ensure the ethical use of data.

# Why Australia Needs to grow its IoT

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Australia needs to make the most of the opportunity afforded by the Internet of Things ('IoT'). While the nation has prospered and benefitted from an unprecedented 27 years of economic growth, many economists argue that our good fortune is mainly due to external factors, such as the demand for iron ore in China or an increase in the oil price, rather than through improvements in the productivity of our industries or workforce.


## Weak Productivity: Australia's Achilles heel

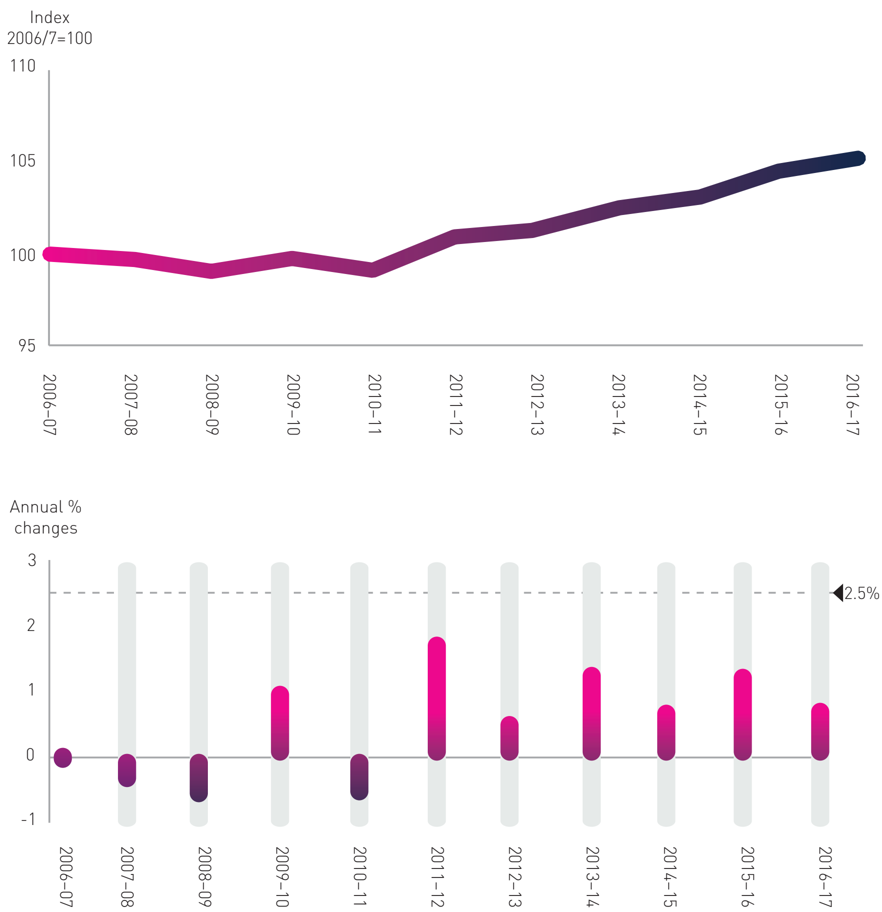
Although Australia's overall productivity is still increasing, growth has plateaued over the last 10 years. Growth in the years leading up to 2011 was flat due to heavy capital investment in mining, which had not yet paid off in terms of increases in output. From 2011, an uptick in productivity occurred due to growth in automation and also to an increase in mining output following the significant levels of investment over the previous decade.

According to Treasury, to achieve a long-run trend rate of 2% growth in GDP, Australia requires an annual productivity growth of around 2.5%. Reaching this target may necessitate significant innovation in not only technology but also fundamental business models and management.

Over the last 10 years, Australia's largest industries have had mixed results regarding productivity. In the financial and insurance services and professional services sectors, productivity growth has been moderate, while in construction and manufacturing it has been low and, in recent years, negative. Mining has fluctuated due to the lag between capital investment and output realisation.

In the long run, Australia's weak productivity growth is costing the economy dearly – for example, through the extraordinarily high cost of new infrastructure – and could make the country uncompetitive in global markets critical for its future.

### Productivity Index (Multifactor) 2006/7–2016/17




Note: Multifactor productivity (MFP) is defined as a ratio of a measure of output to a combined input of multiple factors, for example labour and capital

Source: ABS

## The IoT Productivity Solution

The IoT represents a crucial part of the solution to Australia's productivity challenge. The benefits that the IoT will deliver are significant: efficiency improvements of 15–40% are predicted across key industries for developed nations. These benefits are so substantial that the application of this technology has the potential to shift global economic power structures and significantly influence the competitiveness of countries. Critically for Australia, the industries on which the IoT will have a substantial impact also make up a very significant proportion of the nation's economy and account for the vast majority of exports. Conversely, should Australia fail to leverage the technology efficiently and effectively, it risks a significant reduction in global competitiveness. The question for Australia, therefore, becomes how best, and how fast, to leverage the IoT to its advantage.

## Taking a Much-needed Business View

While a significant volume of material, from videos and articles to books and white papers, has been published on the IoT, both globally and in Australia, the work thus far has three limitations:

1. Most studies look at the IoT through a largely technical lens, often focusing on the discipline that the respective author typically operates in, rather than from an economic or business-focused point of view.
2. Only a handful of studies holistically estimate the impact of the technology on economics and industries. Of these, most have a global or US- and Europe-centric perspective, with few looking at the IoT from an Australian point of view.
3. Most studies take a limited approach, meaning that they describe some use cases and from there draw certain conclusions. There are few attempts to categorise the use cases or identify the more impactful ones in a structured manner so that more holistic conclusions can be drawn.

This report closes some of those gaps by taking a broad business and economic view of the IoT opportunity for Australia and by assessing the revenue and cost implications of the technology on the nation's core industries from a 'bottom-up' perspective. It builds on one of the more comprehensive studies in Australia to date: *Enabling the Internet of Things for Australia* by the Communication Alliance (2015), which provided a detailed description of the technical aspects of the IoT, an overview of activities in other advanced nations and an in-depth assessment of the regulatory environment.

## Cutting Through the Hype

There is no shortage of discussion on the possibilities presented by the IoT. From smart buildings to home automation, from fitness trackers to connected gyms and from info-bots at airports to border security, there are myriad ways our lives could be changed by the mass use of interconnected sensors embedded in everyday objects. While many of these use cases are valid and value-adding, it's important when assessing the broader economic impact of the IoT on Australia to move beyond the hype and concentrate on areas where this far-reaching set of technologies will likely have the greatest effect.

This report aims to guide decision-makers in politics and business on how to both leverage and shape the IoT for the benefit of the Australian economy. There are three broad areas of impact:

- Applying the IoT to enhance the productivity and hence competitiveness of Australia's core industries
- Growing a prosperous IoT industry in Australia
- Applying IoT solutions to address significant societal problems in the longer term.

Australia's IoT industry is already worth close to A$19 bn and is expected to grow rapidly. In this dynamic segment of the ICT landscape, Australian participants have the opportunity to position themselves for growth in several of the key elements of the ecosystem, both locally and globally.

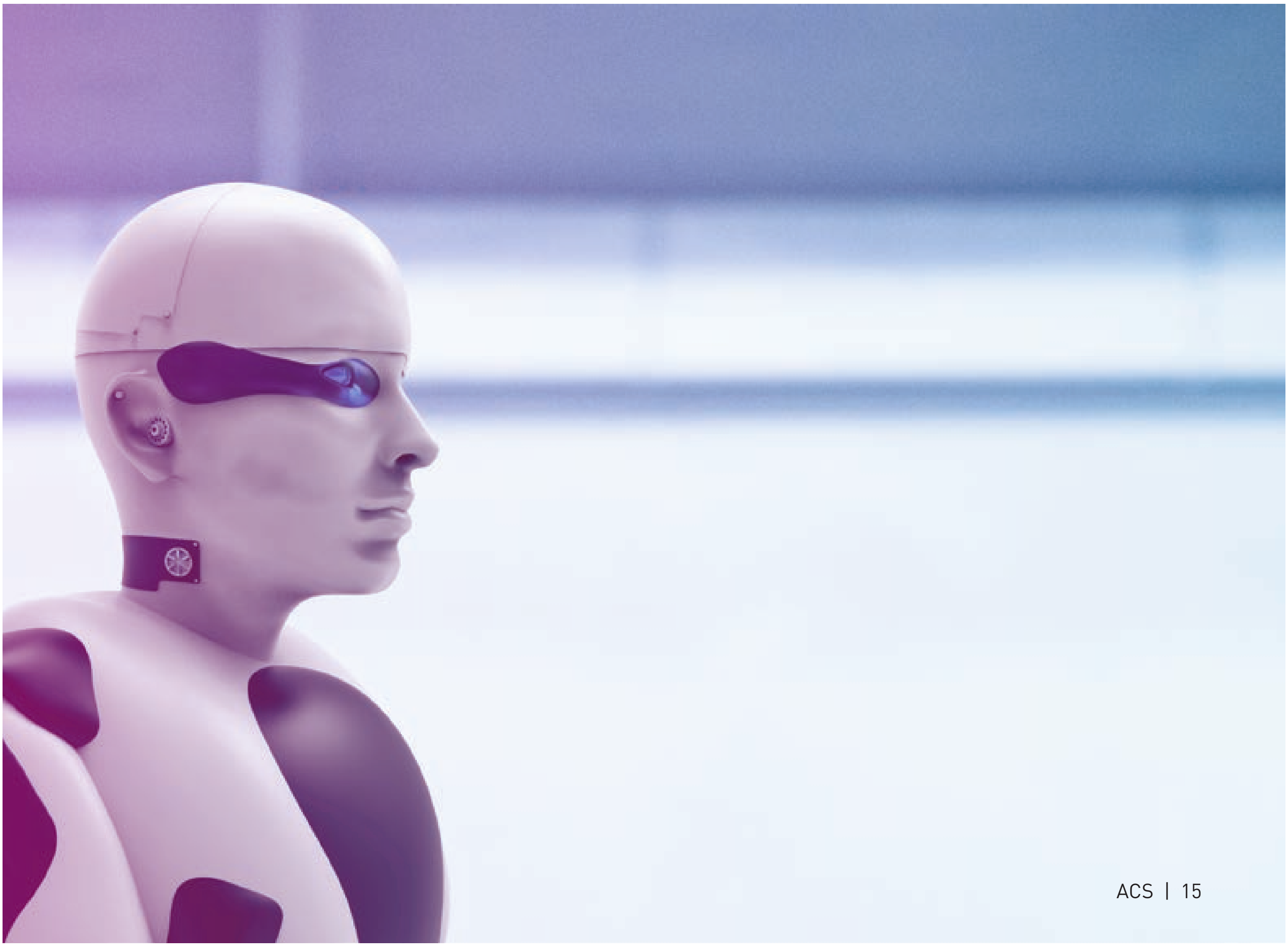
A much more significant impact on businesses and the broader economy, however, will be through productivity increases in some of the nation's most important industries as a result of applying IoT technologies. The effect will be felt in terms of those industries' contribution to Australia's GDP, as well as the competitiveness of the nation's exports. While the technical solutions to unlock some of those benefits are now within reach, the need to address security, organisational and structural challenges are constraining adoption rates.

We also see a third wave of IoT use cases, typically further in the future given their even more impressive implementation challenges, that could address significant societal problems such as resource scarcity, obesity and other chronic diseases, congestion in our cities, or pollution. While the potential social benefit of applying IoT technologies to these issues may be even larger than simply improved productivity, it will also be harder to achieve and will require significant political and behavioural change.

Regardless of their area of interest – productivity or societal change – most observers and all our practitioners, interview partners and SMEs agree that most of the current use cases for the IoT will eventually become a reality; the question is not if, but when.

## Overview of Chapters

- Chapter 2 describes the current rise of the IoT globally, how it generates value, and how it is changing competitive dynamics, business models and industry power structure.
- Chapter 3 demonstrates more clearly than before which of Australia's more significant industries will be affected most by the IoT and quantifies the potential benefits to those industries and the broader economy.
- Chapter 4 refines the definition of the IoT ecosystem, describes the current size, shape and composition of the industry in Australia, and identifies how Australian businesses are positioned in a highly globalised playing field.
- Chapter 5 highlights the significant cyber security challenges that businesses currently face in making the IoT a reality at scale, and outlines the controls and mitigations to manage those risks; it also describes the opportunity for Australia to improve cyber security more broadly through collaboration, education and technology.
- Chapter 6 provides a set of recommendations to government and industry on how best to enable the opportunities that the IoT offers.



# The State of the IoT Globally

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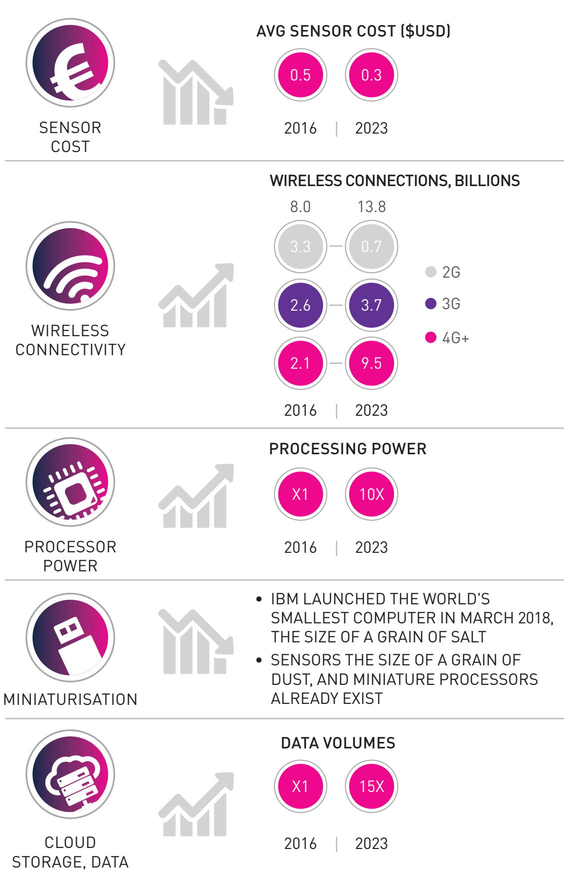
## ECONOMIC BENEFIT TO BE DELIVERED BY THE IOT GLOBALLY BY 2023[4]*

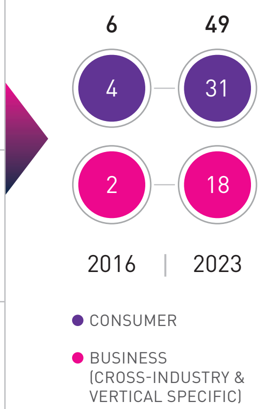
Since the Communications Alliance's study in 2015, predictions of the rapid acceleration of the IoT have not changed significantly. Analysts continue to forecast that there will be between 20 and 80 billion connected devices globally by 2020. The critical ingredients to the IoT's success are still seen as falling sensor costs, continuously improving wireless connectivity, ever-increasing processing power, continuing advances in miniaturisation, and the ability to store and process exploding volumes of data in the cloud.

### TECHNOLOGY TRENDS DRIVING IoT




### IoT UNITS INSTALLED BASE

(BILLION UNITS)




SOURCE: GARTNER, OLIVER WYMAN, IBM, STATISTA, CISCO
PWC STRATEGY& ANALYSIS

Interestingly, some forecasts have reduced slightly over the past 24 months. IDC's total IoT spending expectations, which were initially just under US$1 tr by 2018, are now closer to US$800 bn. We believe this recalibration is driven not so much by challenges with the technology but rather an initial underestimation of the structural and organisational realities of implementing IoT solutions at scale. Regardless, enthusiasm for the technology remains unbroken globally and, if anything, is increasing as further technological breakthroughs are achieved and more and more use cases are implemented successfully.

Over the past two years, a number of trends have further shaped the industry:

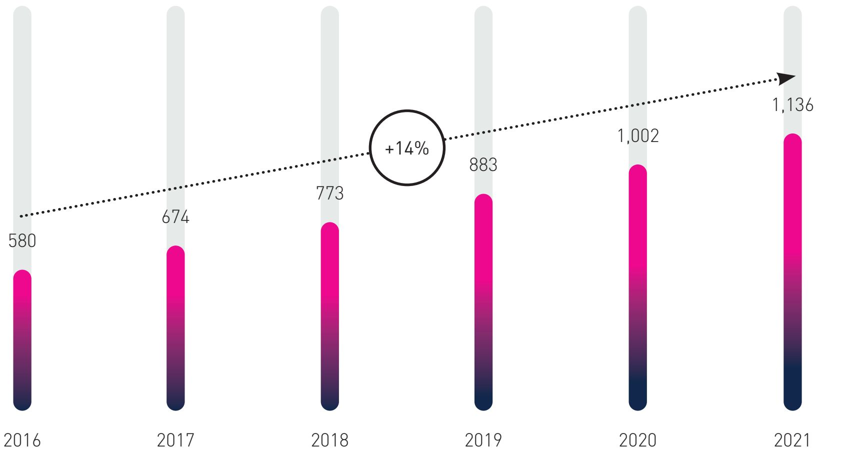
- Reduced acquisition activity offset by an increase in collaboration and partnerships
- Increased competition in the IoT platform battle
- The industry expanding from 'heavy IoT' with systems connecting a few hundred things to 'light IoT' with literally billions of connected things
- Increases in the number of connectivity options available
- Data processing efficiency improving with edge computing reducing data traffic
- Focus on privacy and security further intensifying.

While our interviews globally and in Australia have confirmed these trends, industry participants identified two more fundamental shifts that are starting to emerge:

THE RAPID DEVELOPMENT OF SOFTWARE APPLICATIONS AS THE KEY VALUE DRIVER OF IoT SOLUTIONS

THE EVOLUTION OF BUSINESS MODELS TO CAPTURE THE VALUE THAT IoT SOLUTIONS CAN PROVIDE

FORECAST GLOBAL IoT SPEND OUTLOOK USD$BN 2016–21




SOURCE: IDC

## Value is Shifting to Software

One of the most critical realisations of the past two years is that the highest value of an IoT solution no longer lies in smartly combining sophisticated sensors and actuators but in the artificial intelligence – expressed through software applications – that brings the solution to life. Our analysis highlights the agreement among the major forecasting institutes: growth in IoT hardware and backbone, while significant, is substantially less than growth in associated software, AI and data analytics.

As a result of this shift, we expect to see a reduced relative emphasis on traditional engineering and an increased focus on software development.

For Australia, this development is significant. Traditionally, the country has not focused on establishing advanced electronic or mechanical engineering clusters and lacks the manufacturing base to become a major player in the IoT hardware space at a broad scale.

However, Australia does have considerable software development capability, and the shift from IoT hardware to software provides a significant opportunity for the nation to carve its niche in the global IoT game.

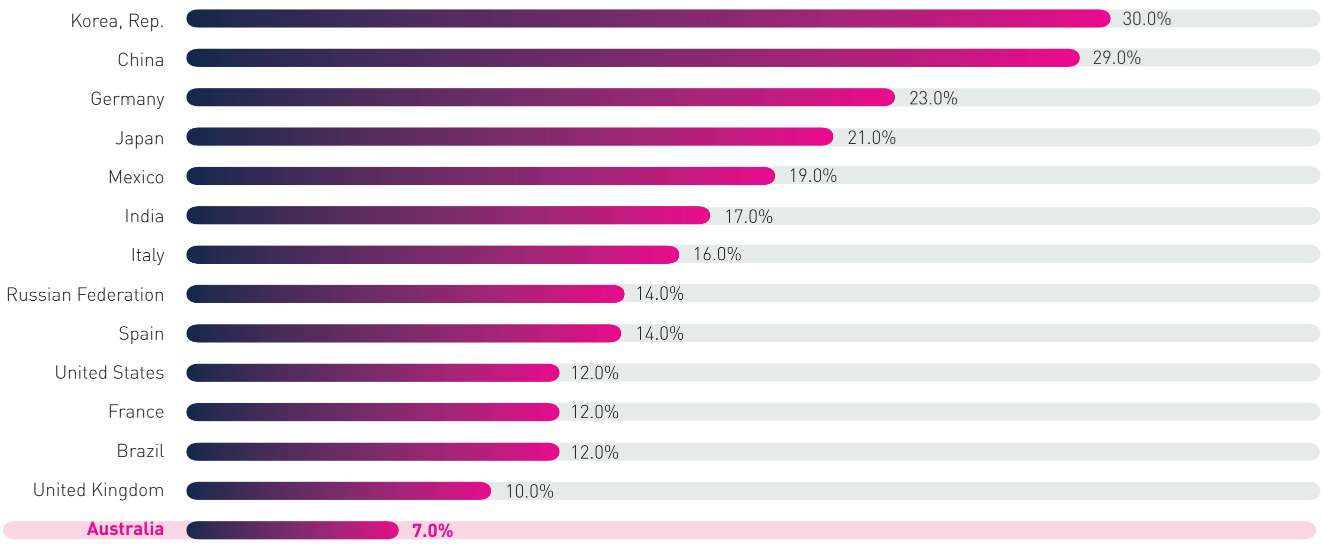
> "Our cloud-based AI solutions have the ability to generate millions in savings for the construction, mining and transport industries through the advanced real time analysis of HD video streams from a handful of cameras that can be purchased for $30 at the local retailer."
>
> Hanno Blankenstein, Founder and CEO of Unleash Live

> "Beginning in the 2000s, we've invested more than $10 billion in industrial software acquisitions. These acquisitions make us the sixth-largest software company in the world."
>
> Joe Kaesser, CEO Siemens

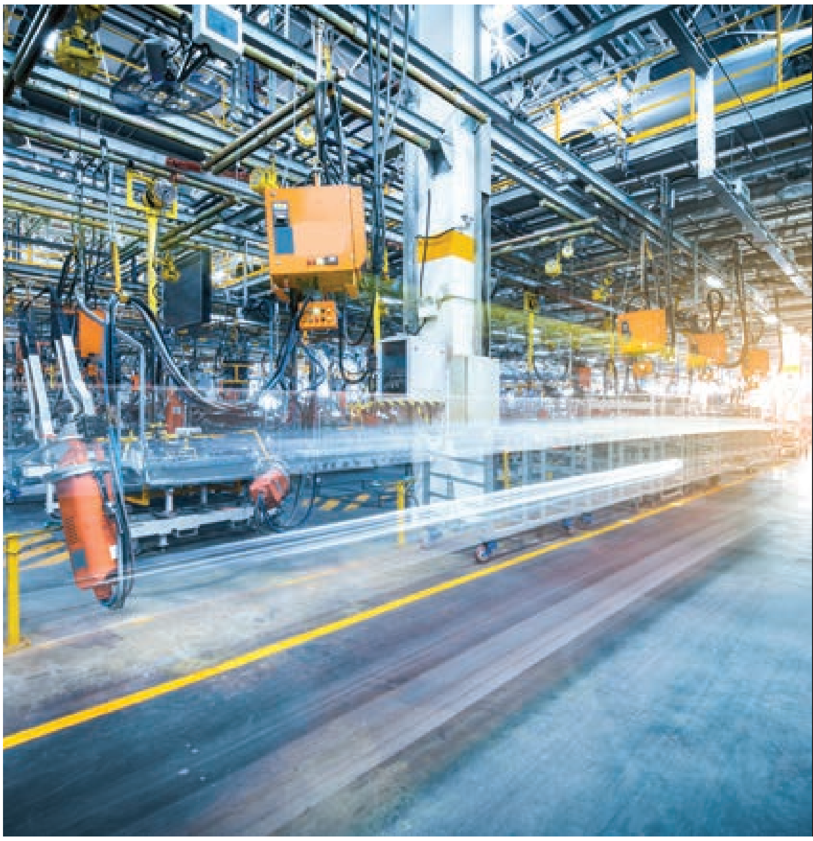
EXPECTED GROWTH RATES OF IoT COMPONENTS 2018–20


SOURCE: IDC, PWC STRATEGY& ANALYSIS

TOP 15 ECONOMIES RANKED BY MANUFACTURING AS A PERCENTAGE OF GDP 2015



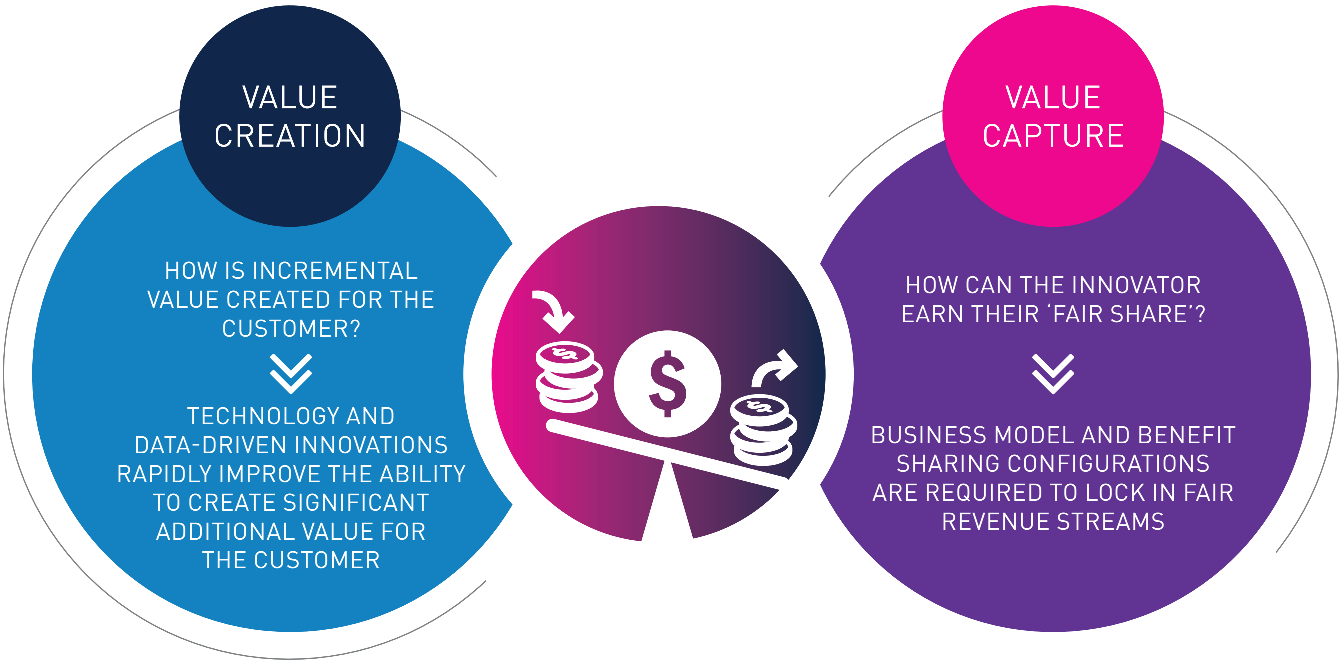

NOTE: EXCLUDES CANADA DUE TO MISSING DATA
SOURCE: THE WORLD BANK



"We are changing the entire business model of the automotive sector at every step of the value chain. We are creating significant value for the consumer through a much improved product, to society through significantly reduced pollution and congestion, and capture this value for our investors through a Mobility as a Service model of unprecedented nature. This is not just our choice, it is the new basis for competition in the rapidly emerging digital future."

Michael Molitor,
Director, Uniti Australia

## Business Models are Evolving




Today, a wide range of companies – from IoT startups like Unleash Live and ecosystems suppliers like Telstra, to industry incumbents like DPDHL or BMW and Industrial IoT giants such as GE and Siemens – have a general understanding of how the IoT can solve technical problems. However, many still struggle to define how an often-transformative IoT solution can fit into their business model, or how a new business model can be structured to best capture the value that the solution creates. This problem becomes particularly challenging in a 'new world' in which partnerships of large and small companies, startups and incumbents, competitors and frenemies need to co-exist. Over the last two years, a move towards an 'IoT mindset' has started to take shape.

# Mindset Shift

## VALUE CREATION

| | FROM<br>TRADITIONAL PRODUCT MINDSET | TO<br>IoT MINDSET | IMPLICATIONS FOR IoT PLAYERS |
|---|---|---|---|
| CUSTOMER NEEDS | SOLVE FOR EXISTING NEEDS AND SITUATION IN A REACTIVE MANNER | ADDRESS REAL-TIME AND EMERGENT NEEDS IN A PREDICTIVE MANNER | NEED TO MAKE SENSE OF DATA QUICKLY<br><br>NEED TO BE NIMBLE IN CONVERTING DATA INSIGHTS INTO PRACTICAL ACTIONS |
| OFFERING | STANDALONE PRODUCT THAT BECOMES OBSOLETE OVER TIME | PRODUCT REFRESHES THROUGH OVER-THE-AIR UPDATES AND HAS SYNERGY VALUE | |
| ROLE OF DATA | SINGLE POINT DATA IS USED FOR FUTURE PRODUCT REQUIREMENTS | INFORMATION CONVERGENCE CREATES THE EXPERIENCE FOR CURRENT PRODUCTS AND ENABLES NEW SERVICES | |

## VALUE CAPTURE

| IMPLICATIONS FOR IoT PLAYERS | IoT MINDSET | TRADITIONAL PRODUCT MINDSET | |
|---|---|---|---|
| NEED TO HAVE A HOLISTIC UNDERSTANDING OF HOW VALUE IS CREATED<br><br>NEED TO BE FLEXIBLE AND NIMBLE IN WORKING WITH PARTNERS | ENABLES RECURRING REVENUE, NEW MONETISATION MODELS AND NEW REVENUE STREAMS | SELL THE NEXT PRODUCT/ DEVICE/SERVICE | PATH TO PROFIT |
| | ADD PERSONALISATION AND CONTEXT AND CREATE NETWORK EFFECTS BETWEEN PRODUCTS AND SERVICES | POTENTIALLY INCLUDE COMMODITY ADVANTAGES (E.G. PRICE, SCALE ETC.), INTELLECTUAL PROPERTY OWNERSHIP AND BRAND | CUSTOMER CONTROL POINTS |
| | UNDERSTAND HOW OTHER ECOSYSTEM PARTNERS MAKE MONEY AND WORK WITH THEM TO LEVERAGE THEIR CAPABILITIES TO MUTUAL ADVANTAGE | LEVERAGE CORE COMPANY COMPETENCIES, EXISTING RESOURCES AND PROCESSES | CAPABILITY DEVELOPMENT |

## PRODUCT PREMIUMS

### PRODUCT FEATURE ENHANCEMENTS

**SELECTED EXAMPLES**

**SMART TENNIS RACQUETS:** BABOLAT MANUFACTURES TENNIS RACQUETS WITH SENSORS ATTACHED, ENABLING PLAYERS TO ANALYSE THEIR GAME AND IMPROVE THEIR TECHNIQUE

**REVENUE MODEL**

CHARGE PRICE PREMIUM

### 'NEXT GENERATION' PRODUCTS

**SELECTED EXAMPLES**

**SELF-DRIVING WARSHIP:** US MILITARY HAS CONSTRUCTED AN EXPERIMENTAL 40M-LONG PROTOTYPE OF A SELF-DRIVING WARSHIP DESIGNED TO HUNT FOR ENEMY SUBMARINES

**REVENUE MODEL**

CHARGE PRICE PREMIUM

## NEW SERVICE REVENUES

### ADJACENT SERVICES

**SELECTED EXAMPLES**

**HOME SECURITY SERVICES:** GIVEN THEIR FOCUS ON CONNECTIVITY, TELECOMMUNICATIONS COMPANIES (E.G TELSTRA) ARE PROVIDING INTEGRATED SECURITY, COMFORT AND HOME AUTOMATION SOLUTION

**REVENUE MODEL**

CHARGE MONTHLY SUBSCRIPTION

### PERSONALISATION SERVICES

**SELECTED EXAMPLES**

**IFTTT (IF THIS THEN THAT) SERVICE:** GE HAS Wi-Fi-ENABLED HOUSEHOLD APPLIANCES THAT CAN RESPOND TO ACTIVITIES AND SEND ALERTS TO OTHER DEVICES, E.G. RECEIVE AND SMS IF A LEAK IS DETECTED, BLINK YOUR LIGHTS WHEN A WASHING CYCLE IS DONE

**REVENUE MODEL**

CURRENTLY DIFFICULT TO MONETISE

### CONSOLIDATION SERVICES

**SELECTED EXAMPLES**

**CONNECTED HOMES:** WINK PROVIDES A SINGLE PLATFORM FOR HOMES TO BE FULLY CONNECTED AND INTERACTIVE BY ENABLING PRODUCTS FROM DIFFERENT BRANDS TO COMMUNICATE WITH EACH OTHER

**REVENUE MODEL**

SELL HARDWARE WITH OPTIONAL MONTHLY SUBSCRIPTION FOR PUSH NOTIFICATIONS

## NEW PRICING STRUCTURES

### USAGE BASED PRICING

**SELECTED EXAMPLES**

**TRUCK TYRES:** MICHELIN USES SENSORS IN TYRES AND ANALYTICS TO HELP TRUCK FLEET MANAGERS REDUCE FUEL CONSUMPTION AND COSTS AND ALLOW THEM TO PAY FOR TYRES ON THE BASIS OF KILOMETRES DRIVEN

**AVIATION TYRES:** MICHELIN CHARGES BASED ON THE NUMBER OF TYRE LANDINGS

**REVENUE MODEL**

CHARGE FEE BASED ON PRODUCT CONSUMPTION

## NEW SOLUTIONS REVENUES

### ASSET OPTIMISATION

**SELECTED EXAMPLES**

**PREDICTIVE MAINTENANCE SERVICES:** EQUIPMENT MANUFACTURES (E.G. THYSSENKrupp) USE THE DATA GENERATED BY THEIR ESCALATORS (E.G. ENGINE TEMPERATURE, SPEED, FRICTION, BRAKING ETC.) TO PROVIDE PREDICTIVE MAINTENANCE SERVICES AND OPTIMISE OPERATIONS

**REVENUE MODEL**

CHARGE SERVICE FEE LINKED TO SAVINGS CREATED

### OUTCOME OPTIMISATION

**SELECTED EXAMPLES**

**AIRLINE MAINTENANCE:** TALERIS (A JOINT VENTURE BETWEEN GE AVIATION AND ACCENTURE) HAS NOW EXPANDED INTO ENTIRE AIRCRAFT FLEET OPTIMISATION; IT WAS ORIGINALLY SET UP TO PROVIDE PREVENTATIVE MAINTENANCE SERVICES ON GE-PRODUCED JET ENGINES

**REVENUE MODEL**

OUTCOME-BASED PRICING – ASSUME ALL THE RISK; PAID ON DELIVERED OUTCOMES

> "In the end, the customer doesn't want a product, nor do they want a service. They want an outcome.... These are sophisticated outcomes that will require digital innovation to deliver, but that's where the world is moving."
>
> Bill Ruh, CEO of GE Digital

These developments suggest that those who want to design, offer or integrate IoT solutions into their or their clients' business models need to understand not only how the solution can work from a technical perspective but also how it integrates into their or their clients' business environment. They also need to understand how they can best monetise the ensuing benefits for the respective stakeholders. The ability to combine IoT technical thinking and 'new economy' commercial thinking is rapidly becoming critical.

One of the more exciting IoT business model opportunities is the emergence of outcome-based models. In these models, the interests of both customers and providers are fully aligned: customers pay for outcomes, and solution providers take on increased responsibilities, including that of ownership, effectiveness and maintenance. The IoT enables this alignment in real time, closing the feedback loop and allowing for immediate measurement of, and hence charging for, the actual business impact achieved.

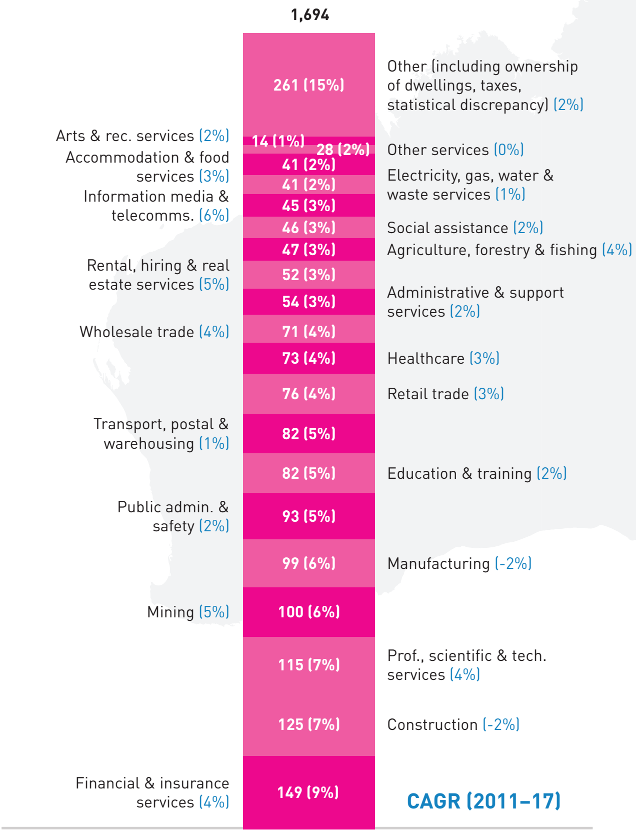
As an example, Rolls Royce provides jet engines as a service for commercial airlines. Airlines pay a fee per engine flying hour, while Rolls Royce takes on the responsibility of owning and maintaining the engines, which are fitted with thousands of sensors. The airlines benefit from simplified operations, and Rolls Royce benefits from increased revenue. Other examples include Michelin providing tyres 'as a service' on a per kilometre basis, or Philips providing lighting 'as an outcome'.

# The Potential Impact of the IoT on Australia's Economy

03

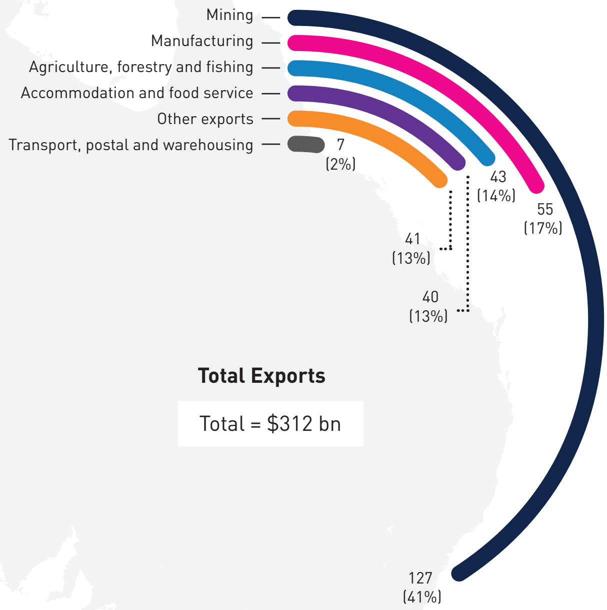
# The Australian Economy

AUSTRALIAN INDUSTRIES BY GDP $BN 2017




Source: ABS

AUSTRALIAN EXPORTS BY INDUSTRY $BN 2015–16




Other exports includes non-money gold and other services (construction services, insurance and pension services, financial services, telecommunications, computer & information services and other business services, personal, cultural & recreational and government services)

Source: ABS, DFAT

## Industry Composition

The Australian economy is A$1.7 tr (GDP, 2016–17)[5] in size and has grown consistently between 2 and 3% per annum over the last 27 years.[6] The largest industries by GDP contribution are financial and insurance services, construction, healthcare, professional, scientific and technical services, and mining. The relative composition of Australia's industries is somewhat consistent with that of other developed nations; however, Australia notably has a large mining industry (the fourth largest in the world)[7] and also relatively large construction and finance and insurance industries, while its manufacturing and information and communications industries are relatively small.[8]

## Exports

Australia exports around one-fifth of all goods produced, equating to approximately A$300 bn in goods and services each year, mainly in mining, manufacturing and agriculture. Trade as a proportion of GDP is relatively lower compared to other countries. China is currently Australia's largest trade partner. Between 2015 and 2016, exports to China grew by 8.9% in value, equating to almost 30% of total exports in 2016. Other important trade relationships are with Japan, the US and South Korea.[9] Across many of those markets and export categories, Australian products face significant competition, and door-to-door cost competitiveness is critical.

Although primary products such as iron ore, coal, beef and wheat represent the majority of Australia's exports, services have increased in relative size. Over the past five years, growth in services such as education, travel and professional services has helped offset lower growth rates in some resource sub-sectors.[9]

## Impact of the IoT by Sector

The benefits that the IoT can deliver vary significantly by industry. Asset-heavy, device-rich and physically intense industries can benefit more – there is a greater number of 'things' to connect, and those things have a larger impact – than industries that are more services oriented.

Consequently, the potential impact that the IoT can have on a nation depends fundamentally on its industry composition. Countries driven more by services sectors will benefit less, while those driven more by manufacturing and manufacturing-related industries will benefit more.

To assess the impact that the IoT can have on an industry, we have undertaken broad secondary research into a set of generic use cases for each industry sector. We have added to this research through a range of expert interviews as well as industry-based working sessions among our own expert teams. This initial focus on generic use cases allows a deeper understanding of the respective application of the IoT across sectors more broadly.

# Assessment of Generic IoT Use Cases

| Use case | Efficiency improvement | | | | | | | Asset management | | | Workplace health, safety & environment | | | Sales optimisation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inventory management | Predictive maintenance | Human productivity | Production/ outcome optimisation | Energy management | Product tracking | Supply chain management | Industrial asset management | Fleet management | Facility management | Health management | Safety and security | Environmental management | Sales enablement | Product development |
| Fin. & insurance services | Low | Low | Medium | Low | Medium | Low | Low | Low | Low | Medium | Medium | High | Medium | Medium | Medium |
| Construction | High | High | High | High | High | High | High | High | Medium | High | High | High | High | Low | High |
| Healthcare & social assist. | High | High | High | High | Medium | High | Medium | Medium | Low | High | High | High | Medium | Medium | High |
| Prof., scientific & tech/services | Low | Low | Low | Low | Medium | Low | Low | Low | Low | Medium | Medium | Medium | Low | Low | Low |
| Mining | Medium | High | High | High | High | High | Medium | High | High | High | High | High | High | Low | Low |
| Manufacturing | High | High | High | High | High | High | High | High | Low | High | High | High | Medium | Medium | High |
| Public admin. & safety | Medium | Medium | Low | Low | Low | Low | Low | Medium | Medium | Medium | Medium | Medium | High | Low | Low |
| Education & training | Low | Low | Medium | Low | Low | Medium | Medium | Low | Low | Medium | Medium | Low | Medium | Medium | Medium |
| Transport, postal & warehousing | High | Medium | High | Medium | Medium | High | High | High | High | High | High | High | Low | Low | Low |
| Retail trade | High | Low | Medium | Low | Medium | High | High | Low | Low | Medium | Medium | Medium | Medium | High | High |
| Wholesale trade | High | Low | Medium | Medium | Medium | High | Medium | Low | Low | Medium | Medium | Medium | Low | High | High |
| Admin. & support services | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Medium | Medium | Low | Low | Low |
| Rental hiring & real estate services | High | Medium | Medium | Low | Low | Medium | Low | Low | Low | Medium | Medium | Medium | Low | Medium | Medium |
| Agric., forestry & fishing | High | High | High | High | High | High | Medium | Medium | High | High | High | High | High | Medium | Medium |
| Info. media & telecoms. | Low | Low | Low | Low | Medium | Low | Low | Low | Low | Medium | Medium | Medium | Low | High | High |
| Electricity, gas, water & waste services | Medium | High | Medium | High | High | High | Medium | High | Low | High | High | High | High | Low | Low |
| Accom. & food services | Medium | Medium | Medium | Medium | Medium | Medium | Low | Low | Low | Medium | Medium | Medium | Low | Medium | Medium |
| Arts & rec. services | Low | Low | Low | Low | Low | Low | Low | Low | Low | Medium | Low | Low | Low | Low | Low |
| Description | Tracking inventory and supplies in retail environments, factories, warehouses and hospitals | Monitoring of machines to predict when they require maintenance which reduces unplanned downtime, extends maintenance cycles, and reduces costs | Using IoT to teach skills, redesign work and manage performance | IoT used to enable primary producers and manufacturers to optimise production processes to maximise the output of primary and manufactured products | Using IoT sensors and smart meters to better manage energy | Monitoring of objects to improve systems' efficiency (such as enhance transparency in order fulfilment, product status in assembly area, locate tools, components and materials) | Managing supply chain relationship including payment processing | Monitoring and managing the location, condition and usage of industrial equipment and machinery | Monitoring and managing the conditions, location and usage of vehicle fleets | Monitoring the design, construction and operation of structures and buildings | Improving health and wellness using IoT monitoring data | Monitoring of facilities and spaces for public safety and commercial security purposes | Improving stewardship of the environment using IoT technology, such as using sensor data to monitor air, water, soil quality | Using IoT usage data to generate new sales | Employing IoT usage to research and development |

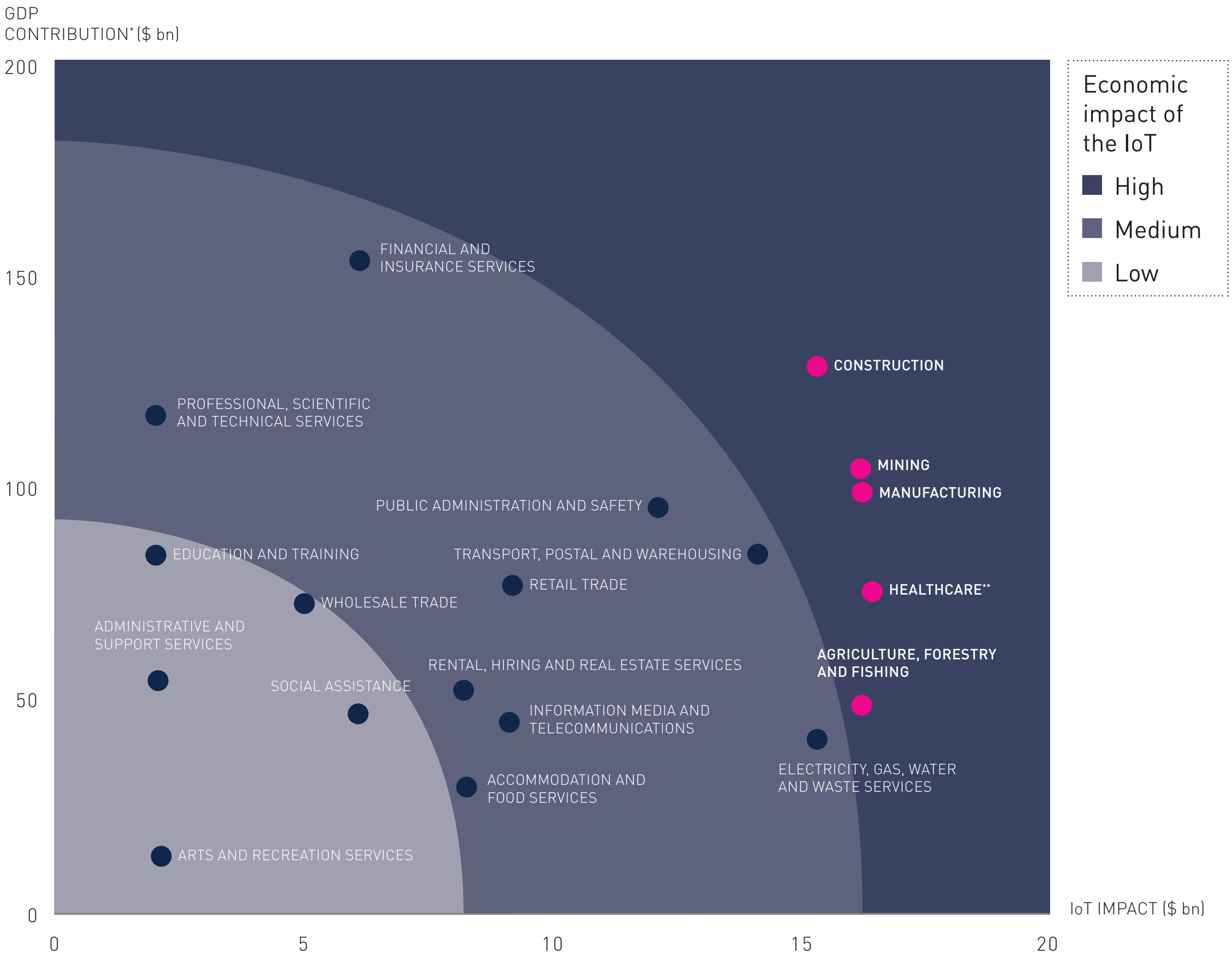
Impact: High / Medium / Low

*Note: This framework does not consider smart consumer products and vehicles, and public safety and security*

## Assessment of Overall IoT Impact

Combining the potential for IoT impact within an industry with the overall relevance of the sector to the economy, and using GDP as a proxy, reveals those sectors where the impact on the economy is greatest. Unsurprisingly, industries, such as construction, mining and manufacturing, that deliver value through the significant use of physical assets came out as high-impact industries, and therefore warrant further consideration and focus. Healthcare and agriculture were also uncovered as industries worthy of further investigation.

Over the following pages, we analyse those five industries in more detail and estimate the potential impact of the IoT on each sector.




*2017 GDP was $1,700 billion (excludes 'Other services' and other data (including ownership of dwellings, taxes, statistical discrepancy)

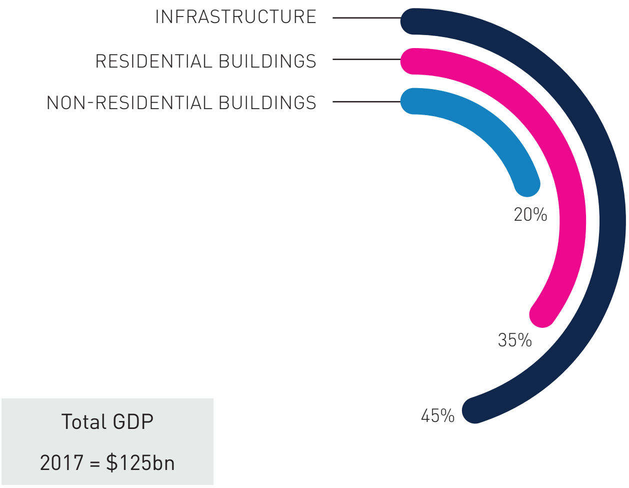
**Excludes government expenditure

*Source: ABS*

# Construction

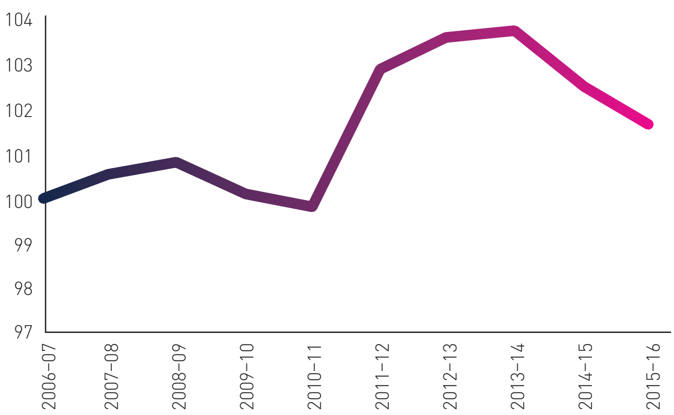
- Total revenues: $378 bn[10]
- GDP: $125 bn, 7% of total GDP in 2017, -2% CAGR 2014–17[5]
- Employment: 1.1m people (10% of total, 2% CAGR 2009–18, Australia's 2nd largest employer)[11]
- Composition and productivity:

AUSTRALIA CONSTRUCTION GDP SPLIT % OF TOTAL 2017




Note: % splits relate to value of work done
Source: ABS

CONSTRUCTION PRODUCTIVITY INDEX BY INDUSTRY
MULTIFACTOR PRODUCTIVITY* 2006–16




*Multifactor productivity (MFP) is defined as a ratio of a measure of output to a combined input of multiple factors, for example labour and capital
Source: ABS

## Industry Overview

Australia's construction industry is mature and growing in line with the broader economy. Continued population growth (population is predicted to double to 43 m in 2056) will ensure long-term relevance and industry growth.[12]

Industry cycles are driven by the interplay of public and private investments and the housing market. Increasingly, public-private partnerships are used as vehicles to fund large infrastructure projects. While a recent slowdown in mining construction, followed by the end of an apartment boom, had put a brake on growth, recent activity in the form of government-initiated infrastructure projects has reversed that trend.

As significant as the construction industry is, it is notoriously underperforming in terms of productivity growth.

This is not only an Australian problem; the construction industry in most developed markets has never significantly improved its ways of working or adjusted structurally to increase productivity, which remained stagnant for several decades while other industries doubled their productivity. A recent Productivity Commission inquiry into the Australian construction industry concluded that productivity growth has been sluggish and that there is significant wastage.[13]

Site operations are particularly inefficient; it is estimated that construction labour, representing the biggest individual cost item, is engaged in productive work only 30% of the time.[14]

Given the significant infrastructure requirements over the next decade and in the long term, productivity improvements would have a major impact on public and private expenditure.

## Trends

**Increasing labour shortage** as a result of continued and increasing volumes of work, Australia's ageing workforce being unable to keep up with the physical demands of onsite jobs in the industry, fewer young people considering construction as a desirable career path, and last but not least continued lack of automation and process improvement. This leads to tightening supply and increasing wages, further inflating prices.[15]

**Competition from growing Asian economies** that are experiencing an unprecedented need for speed in construction as a result of population growth and rapid urbanisation. Some countries in the region have developed accelerated prefabrication systems, and the importation of prefabricated buildings or infrastructure components may naturally push Australia towards more cost-effective solutions. Prefabrication benefits can be significantly enhanced through IoT technology.

# IoT Opportunities: Construction site 4.0


Current example use cases:

**Fastbrick Robotics** has developed a bricklaying robot that can be attached to the back of a truck; using a laser guidance system it can execute end-to-end 3D printing brick construction. In the future bricks could be laid more than 16 times faster than a human and with improved quality and precision. The robot can be connected to a BIM system so that it can read the code for each brick's position.[17]

**SmartSite** has developed technology to improve construction worker safety and compliance. Sensors monitor harmful onsite factors including noise, radiation and particulates, providing alerts when there is an emergency and automating OH&S reporting.

**AutoDesk Fusion Connect** provides a sensor solution that tracks equipment and monitors equipment data such as internal sensor feedback, helping companies track assets and cut costs, as well as comply with noise and vibration regulations. Similar technology is being pilot tested to track labour. For example, during the construction of Dubai International Airport sensors were used to monitor 10,000 staff for security and timekeeping purposes. This innovation saved 10,000 person-hours per month onsite compared to the manual system and also allowed improved management of visa, health and medical requirements.[18]

## The IoT Opportunity: Construction site 4.0

The opportunity that the IoT brings to the construction industry, which has changed little in terms of 'ways of working' in decades, is enormous.

In the future, construction sites will consistently use Building Information Modelling (BIM). While not strictly an IoT technology in all its elements, BIM is nonetheless a powerful planning and management tool that enables a digital 3D model of the structure to be developed pre-project, with additional information about cost, time, material characteristics, etc., on all elements of the object down to the last screw. It allows fully digitalised planning processes and enables a myriad of other technologies to leverage the underlying data.

In the future, BIM systems will be the centre of the construction site. These systems will be updated in real time automatically through the use of sensors on key materials or prefabricated parts, to improve project tracking. They will be able to forecast upcoming issues and present options for resolution to significantly reduce delays from poor planning. Having all the information in one place through the use of a cloud solution will also allow information to be more readily available to relevant parties without direct communication (90% of project managers' time is communications).[16]

The extensive use of connected sensors will have the potential to further improve information flow across sites, thereby reducing delays and rework. Quality checks (e.g. vibration sensors to identify defects) can happen in real time.

Monitoring of critical machinery will enable preventative maintenance by pre-empting issues. Tracking of tools and inputs as well as inventory replenishment can occur automatically.

Drones will be used to collect aerial information, survey the land and site, collect topographical and volumetric measurements and for security purposes. This level of data across the process will make construction sites much more 'factory like', improving transparency and allowing KPIs to be established and tracked to enhance productivity significantly. Sensor data can also be leveraged post-construction, enabling patterns of usage, energy or temperature to be monitored to further improve upon future design and construction.

The future construction site will also be much more automated. Robots will be used to perform repetitive, dangerous or heavy tasks. 3D printing onsite will enable the fast production of specific parts, and 3D laser technology can automate land surveying (e.g. pipe locations) and feed directly into BIM systems.

### Impact Summary

**Total benefit:** $75–96 bn

Construction has been one of the slowest industries to adopt any form of process innovation over the past 50 years or more, well before the IoT. At the same time, the industry is characterised by physical activities and the use of a significant amount of technical equipment. The combination of those two factors makes for very substantial potential benefits from the IoT.

Our modelling indicates that benefits of 22–29% of the total cost base are achievable, equating to $75–96 bn in annual benefits.

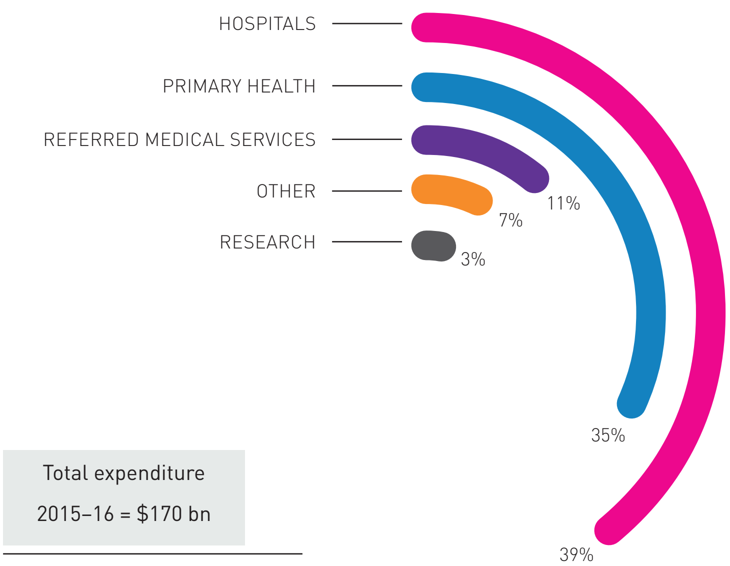
Those benefits would be reflected in significantly reduced government expenditure for desperately required infrastructure. Downstream industries such as mining and transport would be more efficient and cost competitive and, importantly, the cost to the individual of building a family home or unit would also reduce. There would be a reduced impact on the environment through much faster building times, reduced logistical efforts, less wastage, lower greenhouse gas emissions and general operational improvements. There would also be worker safety benefits and the potential to improve construction outputs through better design and higher quality.

There are, however, significant hurdles that will need to be overcome to achieve those benefits. These include addressing deeply entrenched ways of working in an industry that is notoriously resistant to change. Also, government as the key customer to the industry in many cases does not have the capabilities to act as an informed customer and create a 'pull for innovation', be it product or process related.

# Healthcare

- Total expenditure (2015–16): $170 bn[19]
- GDP: $49 bn, 3% of total GDP in 2017, 6% CAGR 2014–17[5]
- Employment: 791k people (6% of total employed, 4% CAGR 2009–18)[11]
- Composition:

AUSTRALIA HEALTHCARE GDP SPLIT % OF TOTAL 2017




SOURCE: AUSTRALIAN GOVERNMENT

## Industry Overview

Healthcare makes up 3% of total GDP. It covers health services such as hospitals, GPs, dentists, ambulance services and research, but excludes social assistance such as residential and child care.

Australia's public health system is complemented by a private healthcare sector, and while the two systems operate alongside each other to ensure quality care and choice for all Australians, they have significantly different motivations, dynamics and economics.

Including government expenditure, Australia spends approximately $170 bn on healthcare annually (2015–16), a figure that includes hospitals ($66 bn), primary health (including GPs, dentists, community health) ($60 bn), referred medical services ($18 bn), other ($12 bn) and research($5 bn).[19]

Australia's healthcare system is considered to be one of the best in the world, ranking sixth in terms of healthcare efficiency and seventh in terms of life expectancy. [20] Despite being relatively efficient, costs have been rising faster than economic growth and population growth.[19] [21]

While other industries have reinvented their delivery models, technology base and value chain, healthcare in Australia has remained relatively unchanged. Australia's growing and ageing population will, therefore, continue to drive overproportioned cost increases, ultimately making the current model unsustainable, unless more fundamental ways are found to deliver the same high quality of outcomes at significantly reduced cost.

# 1. Hospitals

## Trends

All Australians are eligible to be treated in a public hospital without charge, while private hospitals primarily focus on elective procedures. In 2015–16, 10.6 million hospitalisations occurred in public and private hospitals.[22]

**An ageing and growing population** will increase demand on the Australian healthcare system as elderly people and expectant mothers heavily rely on healthcare services. This will increase wait times and reduce health outcomes unless productivity improvements are made, such as through use of the IoT to further reduce the length of hospital stays and the frequency of admissions.

**Longer wait times** are driving an increased gap between services required and services available. Waiting times in emergency departments and for elective procedures are too long. In 2015–16, about 2% of the 700,000 patients admitted for elective procedures in public hospitals had to wait longer than a year. [23] There is a view that efficiency improvements can be made to free up capacity, including ensuring only procedures with proven effectiveness are performed, increasing the focus on preventative medicine, and increasing automation and use of technology such as the IoT.

**An increase in chronic disease** is leading to a rise in hospitalisations and interventions. Between 2009–10 and 2013–14, hospital admissions increased at twice the rate of population growth, an effect largely attributed to the increase in chronic diseases such as diabetes and obesity.[24]

The IoT can aid in the management of chronic disease through remote monitoring, analytics and mobile platforms. For example, IoT innovations have been repeatedly shown to cut re-admissions of high-risk patients with congestive heart failure by more than half.[25]

**An increase in preventable conditions** causes inefficient use of hospital beds and resources. It is estimated that 8% of all 'bed days' are due to related conditions; for example, diabetes-related lower limb amputations that could have been prevented through effective primary care or public health interventions.[26] The use of sensors, such as wearables, can help monitor health and improve early intervention or prevention.

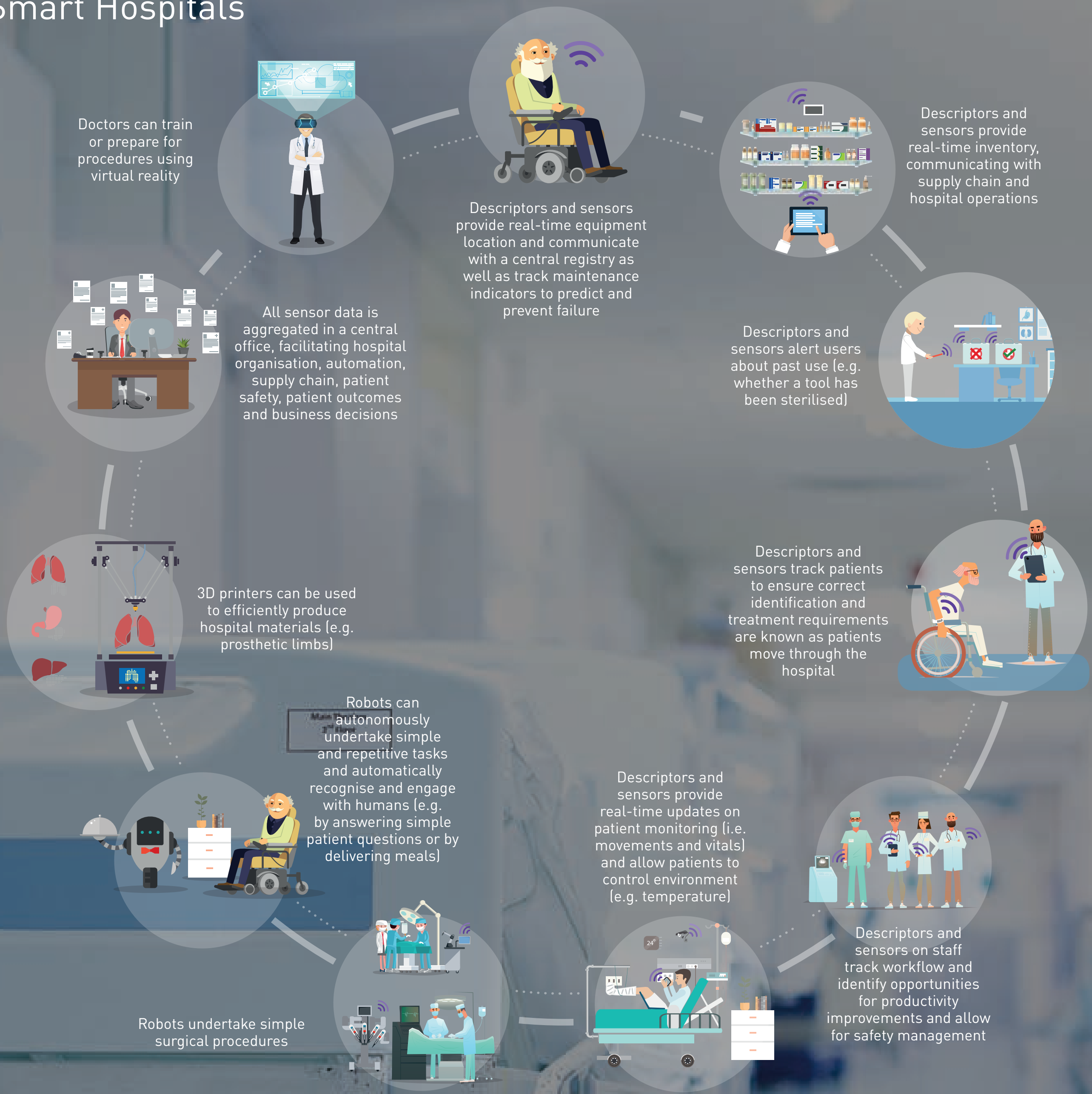
## IoT Opportunity: Smart Hospitals

The 'smart hospital' is built on an optimised and automated system of interconnected IoT systems. This design allows for improved management of supplies inventory (including tracking and reordering), optimised patient environment and monitoring (e.g. temperature, location), staff (e.g. task optimisation), assets (e.g. proactive maintenance, balanced utilisation) and tools (e.g. doctors can know whether a tool has been sterilised or not). Robots will be used to perform simple procedures and tasks (e.g. give patients their medicine and provide basic information). Some experts believe that as much as 80% of activity could, in theory, be replaced by machines and algorithms.[27]

Hospitals will become much more personalised, with higher data availability and technology such as 3D printing, robotics, nanotechnology, genetic coding and therapeutic options (e.g. 3D printing of prostheses will be based on a patient's individual anatomy). Patient data will be collected and stored centrally, allowing seamless data sharing between hospitals and primary and secondary care to improve the patient experience. The abundance of data will also unleash the potential to uncover more effective treatments through aggregation and big data analytics.

These advancements will also open up new delivery models. For example, some care previously provided in hospitals may be transferred to the home as the use of wearables and other interactive devices allow the remote monitoring of vital signs or even administration of medicine. There are already examples of wearable technology reducing admission rates for specific illnesses by 10–30%.[28] [29] Virtual reality may create new learning and development opportunities for doctors (e.g. help surgeons map out surgeries before conducting them).

# IoT Opportunities: Smart Hospitals




## Current example use cases

**GE** partnered with a hospital in New York to connect and track hospital beds using sensors. These sensors enabled hospital operators to tell when a bed was free and helped reduce emergency room wait times by as much as four hours and improved patient outcomes.

**Philips Healthcare** recently rolled out an IoT solution called e-Alert, which is a hardware/software solution that remotely monitors the health of its machines. The system sends a text to an engineer so a repair can be made before damage or an outage occurs, thereby improving patient outcomes and reducing maintenance costs.[30]

**Queen Elizabeth Hospital** in Glasgow introduced 26 robots to manage medical equipment, lines, food and waste. They perform 10% of the hospital's operational tasks, a figure that could increase to 25% by 2025.[31]

**SensorMetrix** provides wireless sensors in hospital refrigerators, freezers and laboratories to ensure that blood samples, medications and other materials are kept at the proper temperature, helping reduce labour and wastage.

**The Ramsay Group** is working on patient wearables that improve safety and allow centralised location review and the identification of bottlenecks and other inefficiencies. The company is also starting to deploy video systems that monitor rehabilitation in the home, allowing faster discharge from hospital.

# 2. Primary Health and Referred Medical Services

## Trends

Primary health is the entry point to the health system. It includes a broad range of services, including general practitioners, nurses, allied health professionals, midwives, pharmacists, dentists and specialist services. While delivery models across these services have remained stagnant over the last 50 years, customer expectations are changing and demand is increasing.

**Out-of-pocket expenses are increasing,** driven by changes in Medicare coverage. This puts pressure on the system down the track when conditions are not adequately dealt with during early stages.[32] To prevent health outcomes declining over time, the current delivery model needs to be challenged. IoT can help by delivering significant efficiency benefits.

**An increasing inability to access care** is a growing concern for elderly people and chronic disease sufferers, and for those who live in remote locations. A 2013–14 ABS survey found that nearly one in three people living in outer regional, remote or very remote areas waited longer than they felt was acceptable to get an appointment with a GP, compared with just over one in five people in major cities.[33]

**An ageing and growing population** will put further pressure on Australia's primary care system. There will also be an increased burden from rising levels of chronic disease. The IoT can significantly improve chronic disease outcomes; for example, through remote real-time monitoring.

## IoT Opportunity: Smart Care

The future of primary and secondary care will take advantage of new delivery channels, be more streamlined and will use data to improve the patient experience. Patient data will become more seamless. Having greater access to patient data will enable healthcare professionals to get up to speed more quickly and improve communications across providers.

The level of data collected through the use of wearables and other sensors will also enable vital signs to be monitored remotely, thereby reducing the number of appointments. For example, a 'virtual rehab' that uses new sensory devices that are mobile connected can guide orthopaedic patients through their daily exercise routines, allowing clinicians to remotely track progress and adjust activity as required.

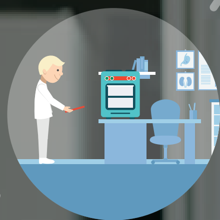
# IoT Opportunities: The Future of Primary and Secondary Care

Doctors will be able to access full patient data and history using a central repository where data has been collected from previous hospitals and doctor visits as well as from wearables

Patients can share and add wearable data to a central repository, which their carers can access; wearables can also remind patients to take their medicine

Descriptors and sensors provide real-time inventory and material location, and communicate with supply chain and clinic operations

Sensor-enabled equipment will allow patients to receive care remotely; doctors can monitor vitals and adjust treatment as required



Descriptors and sensors allow for temperature control on expensive vaccines to reduce wastage as well as track usage

## Current example use cases

**Propeller Health** is developing inhalers for chronic obstructive pulmonary disease (COPD), which connects to its digital platform via a sensor, passively recording and transmitting user data. Subsequent optimisation lowers the number of asthma attacks by 79% and therefore reduces doctor visits.[34]

**QardioCore** is an ECG monitor designed to provide continuous medical-grade data. Users can wear this device in everyday situations: at work, the gym, or out and about. The data helps patients to better monitor health conditions such as high blood pressure and cholesterol. It also sends information to health centres that monitor conditions such as diabetes, heart disease and weight gain, without the need for physical visits.

**Weka** has developed a 'smart fridge' that provides automated controls supported by the IoT and the cloud. It monitors inventory as well as temperature to reduce labour, spoilage and theft.

The IoT will also aid in the efficiency of operations. A network of sensors will reduce manual labour and wastage; for example, building and facility parameters such as temperature and humidity can be automated to manage the patient environment better and keep supplies in optimal conditions. Inventory can be managed automatically; for example, sensors can track, and AI can predict, when specific materials will run out and automatically order more, thereby streamlining the entire supply chain. Sensors can also monitor critical maintenance indicators on key assets, allowing for predictive maintenance to occur (e.g. on X-ray machines).

## Impact Summary

**Total benefit:** $34–68 bn

The impact that the IoT could have on the broader healthcare industry is enormous. Operational productivity could be improved significantly.

Closer monitoring of hospitals and the primary and secondary sector via increased data collection could enable better risk management. The patient experience could be enhanced through greater personalisation and increased choice regarding delivery channel. Remote care, in particular, could improve substantially. The application of the IoT to medical research and medicine production, particularly through the analysis of increased volumes of data, could enable higher quality medicine to be produced at a lower cost.

Due to the diverse range of influencing factors, quantifying all of the potential benefits in healthcare is more complex than in the other identified industry sectors. We have not attempted to model the benefits of broader societal effects through the reduction of chronic diseases or data-driven improvements in research that may lead to step changes in treatment methods. Instead, we have focused on the increase in overall operational efficiencies.

In this context, we estimate that IoT technology could create benefits of 20–40%, particularly through the improved productivity of existing practices as well as the reduced demand for services as a result of earlier intervention, streamlined diagnosis and treatment, and earlier discharge from the system.

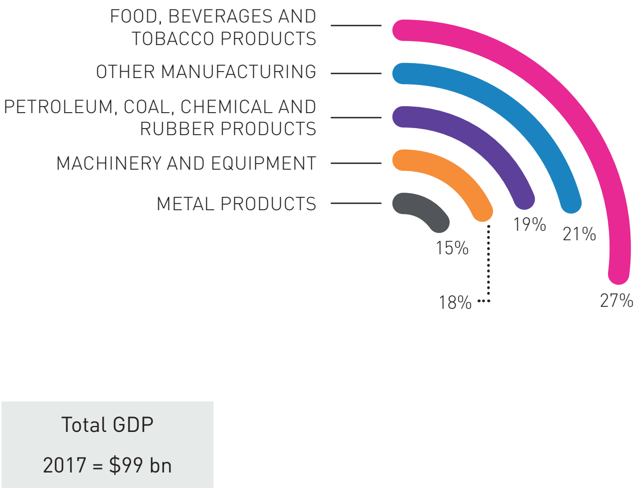
This would equate to an annual benefit of $34–68 bn. Achieving these types of efficiencies will better enable Australia to deal with the growing and ageing population, make the health system more sustainable and improve health outcomes and life expectancy.

However, there are significant hurdles that will need to be overcome to achieve those benefits. These include regulatory and compliance adjustments and an improved approach to data privacy. Also, practitioners will need to adapt to new ways of working, some of which may require significant upskilling. Most importantly, regulators will need to alter significantly the incentive structures for the industry to change entrenched ways of working that currently stand in the way of innovation.

# Manufacturing

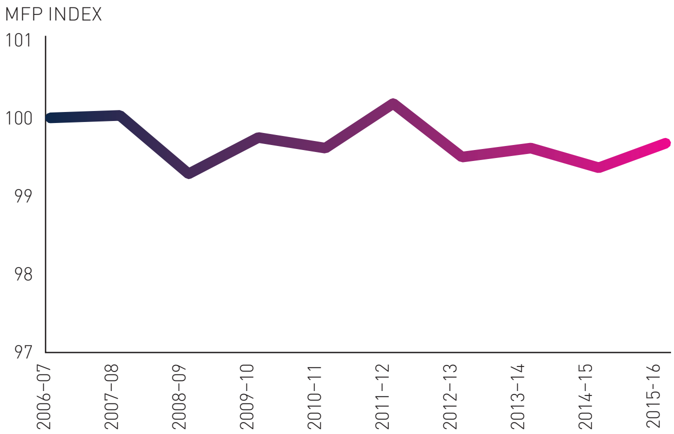
- Total revenues: $378 bn[10]
- GDP: 6% of total GDP in 2017, -2% CAGR 2014–17[5]
- Employment: 901k people (7% of total employed, -1% CAGR 2009–18)[11]
- Composition and productivity:

AUSTRALIAN MANUFACTURING GDP SPLIT % OF TOTAL 2017




SOURCE: ABS

MANUFACTURING PRODUCTIVITY INDEX MULTIFACTOR PRODUCTIVITY* 2006–16




*Multifactor productivity (MFP) is defined as a ratio of a measure of output to a combined input of multiple factors, for example labour and capital.

SOURCE: ABS

## Industry Overview

Manufacturing is Australia's sixth largest sector, accounting for 6% of total GDP in 2017. The industry encompasses the production of a broad range of products, including food, beverages and tobacco, textiles, chemicals, metals and plastics, and more. It represents 17% of Australia's total export revenue (1% CAGR (2011–16). However, Australia is only ranked 21st in the world for competitiveness in manufacturing, and the sector has been on a steady decline as a share of the overall economy over the last 30 years.[35] Employment has also declined, and growth in productivity has plateaued.

This deterioration has been driven by increased competition from lower-cost economies, a challenge faced by most developed nations.

The reaction to competition in other countries has often been to specialise in higher value parts of the sector, upskill the labour force, and, critically, adopt automation and technologies such as the IoT. In fact, manufacturing is the sector with the most advanced IoT applications implemented currently. While the response in Australia has been lacklustre, recent startup activity leveraging more advanced and agile technology, for example around the declining automotive industry in South Australia, demonstrates promising improvements.

However, a number of structural issues plague the industry. These include high labour costs, high logistics costs due to Australia's location and geography, and a small and dispersed national market, which makes it challenging to achieve scale, usually critical for manufacturing efficiencies.

## Trends

### Food, beverage and tobacco products

Food, beverage and tobacco products comprise the largest subcategory within the manufacturing industry sector (27% of manufacturing GDP in 2017). This sub-industry relies heavily on primary industries (agricultural) where Australia has a reliable supply base. Domestic and international demand for Australian products has experienced double-digit growth in the past few years, and 'Brand Australia' is particularly strong in food.[36] However, the segment is under pressure as price deflation caused by supermarket competition has forced food and grocery producers to cut costs, a task that has been made more difficult due to rising labour, energy and regulatory costs.

**A growing population** will ensure stable growth for food manufacturing in Australia, giving producers incentive to increase capacity and improve productivity.

**Intensifying retail competition** will continue as more international players enter the Australian market, putting pressure down the supply chain.

**The focus on food safety** is increasing due to greater trade with Asia as well growing concern among consumers.[37] This requires careful monitoring of the production environment, including contamination, temperature and other factors.

### Metal products

Metal products account for 15% of manufacturing GDP. The industry takes primary metals (e.g. smelt, refined iron, iron sands, carbon and chromium) and converts them into basic products such as slabs, bars or sheets. These basic products are converted into metal products such as general hardware tools, ammunition, door handles, razors and cutlery. While the industry relies on primary inputs, which Australia has in abundance, it does not usually produce complex products and hence faces intense global competition from low-cost markets. As a result, the metals products industry is in decline.

**Intensifying competition** from manufacturers in China and other Asian countries, which benefit from lower operating costs and greater economies of scale, means that imports will continue to take share from local players.

**Substitution** with non-metal products is a challenge for some segments within the industry, notably where plastic or ceramic household goods such as blinds, pipe fittings and bathroom fixtures have similar attributes to fabricated metal products. Non-metal products are often also lighter than metal ones, removing some protection against imports as they can be shipped more economically.

### Machinery and equipment

Machinery and equipment account for 18% of manufacturing GDP and 29% of manufacturing export revenue. The sub-industry tends to have a high share of imported intermediate components that it converts into machinery and components parts used for other industries (e.g. agriculture, mining, construction and healthcare) and consumer goods (e.g. household appliances, lighting, cars and telecommunication devices). This sub-industry is exposed to intense competition from imports and, overall, is in decline except for some areas where Australia has niche expertise (e.g. specific medical device manufacturing).

**Import competition is increasing** from countries with lower operating costs.

**Shifting of production offshore:** Some key industries, such as mining, have reduced capital expenditure and started shifting some production overseas, thereby reducing demand for machinery.

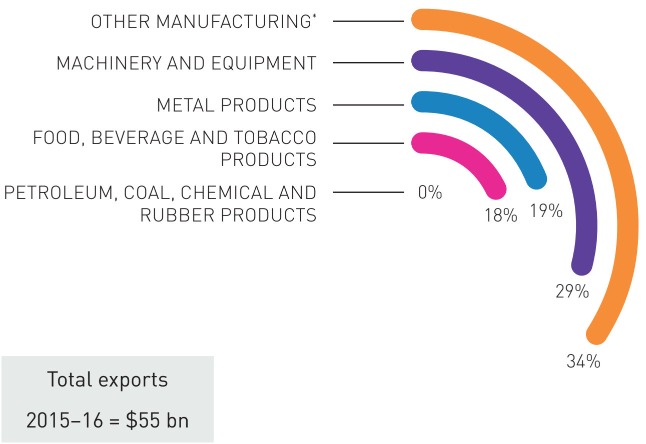
### Petroleum, coal, chemical and rubber products

Petroleum, coal, chemical and rubber products account for 19% of manufacturing GDP. This sub-industry generally takes primary inputs such as crude oil and converts them into final and intermediate goods such as petrol, fuel oil, rubber and basic chemicals.

**Intensifying competition:** High import growth and the contraction of the Australian industry will continue as international players take advantage of lower production and labour costs and technological efficiencies.

**Environmental focus:** Increasingly, organisations and consumers are shifting towards renewable energy sources and away from coal and petroleum and other types of chemicals.

AUSTRALIAN MANUFACTURING EXPORTS BY SUB-INDUSTRY 2015–16 $BN




*Include household goods, clothing and textiles and others
Note: Petroleum, coal, chemical and rubber products have been captured in mining exports revenue
SOURCE: DFAT, ABS

## IoT Opportunity: Industry 4.0

The stable and controlled setting in which manufacturing typically operates combined with the large number of 'things', such as machines and sensors, creates the ideal environment for the IoT. In fact, on a global level, manufacturing is probably the most advanced industry in terms of IoT adoption at this point. Factories could largely become remote-controlled and possibly autonomous through the use of IoT and associated technology. A network of sensors on inputs, assets and outputs will enable complete real-time connectivity and transparency of all the elements and the environment. Supplies and inventory can be monitored and replenished automatically when stocks reach a certain level.

Maintenance indicators, such as temperature or vibrations, will enable preventative maintenance before failure on critical machinery, reducing costly downtime. Improved transparency of production processes will allow autonomous, real-time optimisation, while sensors on final products can monitor quality issues and identify opportunities to enhance the customer experience. Through the use of big data and AI, the system may eventually self-optimise. Once factories become connected to one another, entire supply chains can be optimised in real time. The scale of the individual factory may become less critical, with more flexible production facilities producing smaller batches of products just as efficiently as large plants.

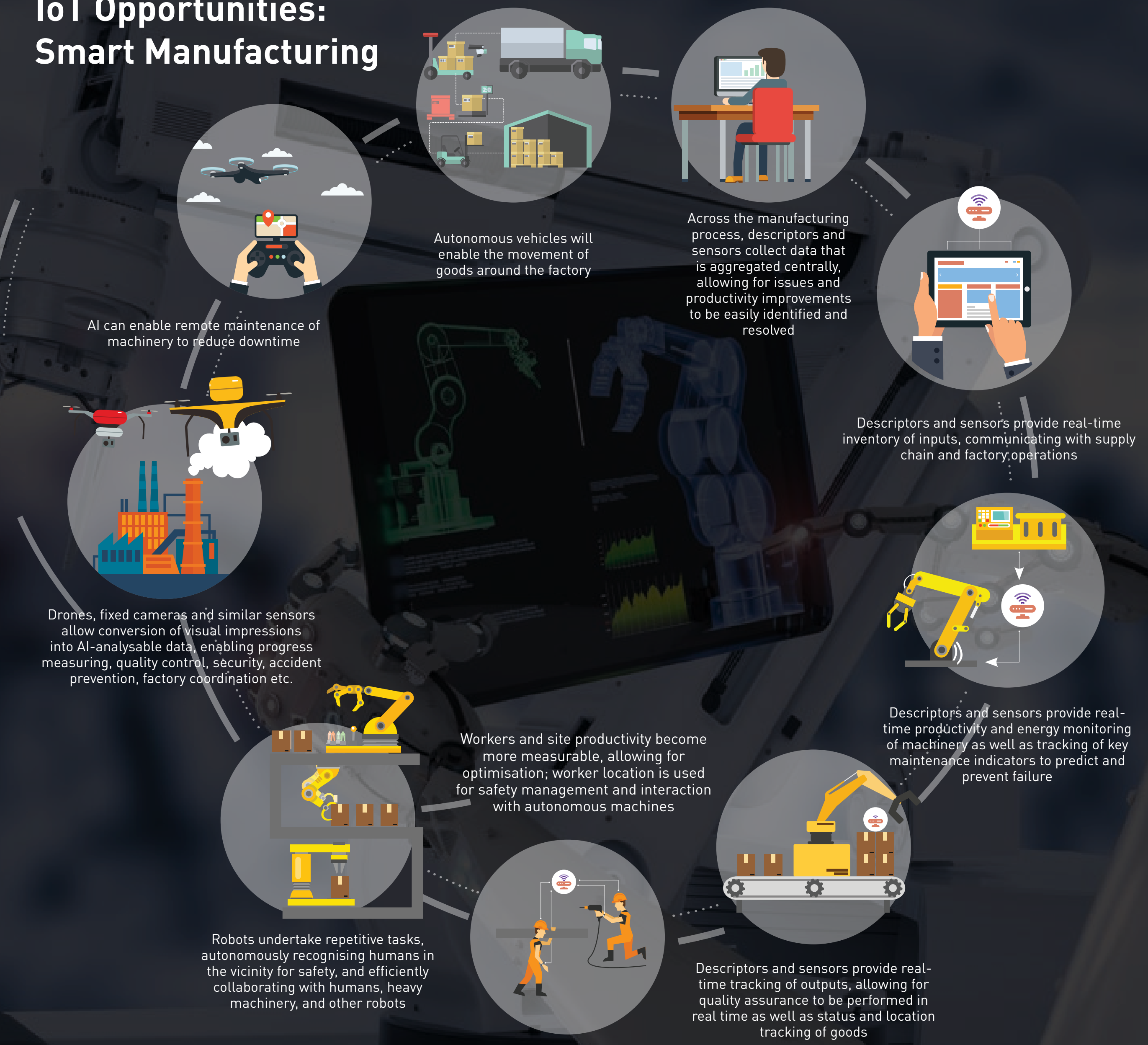
### Impact Summary

**Total benefits:** $50–88 bn

Industry 4.0, one of the more advanced concepts of the IoT era, emerged from the manufacturing space. As such, the sector is globally one of the most advanced in automation in general, and in the IoT in particular. However, with most of Australia's manufacturing sector somewhat less complex, benefits may not be as significant as could be expected in some other developed markets. We estimate that Australia's manufacturing sector can create benefits in the order of 14–25% ($50–88 bn per annum).

The challenges to overcome include a fragmented industry structure, limited high-value manufacturing where the IoT would typically generate more benefits, as well as a limited culture of innovation in many of the sub-sectors.

# IoT Opportunities: Smart Manufacturing




Current example use cases

**Ford** has placed IoT sensors on virtually every piece of production equipment at its River Rouge facility outside Detroit. Downstream machines can detect whether components they receive from an upstream machine deviate in the tiniest dimension from specifications, thereby indicating possible problems in upstream machines that can be immediately identified and fixed.

**Walter Technologies** has developed a wireless solution called the Surfox Smart Passivation Tester that allows on-the-spot quality testing for stainless steel, therefore reducing the time and money required to engage third parties to undertake testing.

**Texmark** has designed a 'refinery of the future' and created an IoT network through the deployment of sensors across assets. The company is using analytics to predict issues across the refinery process; for example, the system will automatically take into account how a problem with a pump might impact the boiler system downstream.

**Tetra Pak** uses cloud-connected machines to predict when machinery needs maintenance to pre-empt and avoid breakdowns, which can halve production for up to five days if a specific part is required.[39]

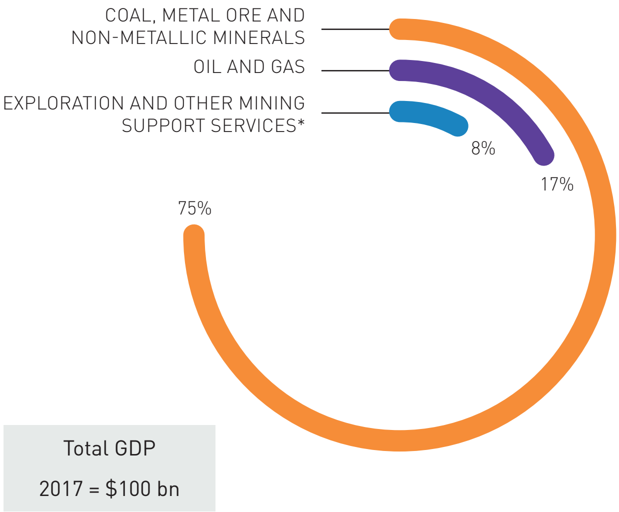
**General Motors** leverages sensors to monitor humidity conditions while vehicles are being painted; if the environmental conditions are unfavourable, the vehicle or part can be moved elsewhere in the facility or the ventilation systems adjusted as necessary.

**Airobotics** has developed an end-to-end drone solution for industrial facilities such as chemical plants, refineries and manufacturing sites. Flight plans can be set allowing drones to automatically provide up-close aerial information about critical plant infrastructure, gas leak determination, security and remote hazard detection.

# Mining

- Total revenues: $179 bn[10]
- GDP: $100 bn, 6% of total GDP in 2017, 5% CAGR 2014–17[5]
- Employment: 229,000 people (2% of total employed, 3% CAGR 2009–18)[11]
- Composition and productivity:

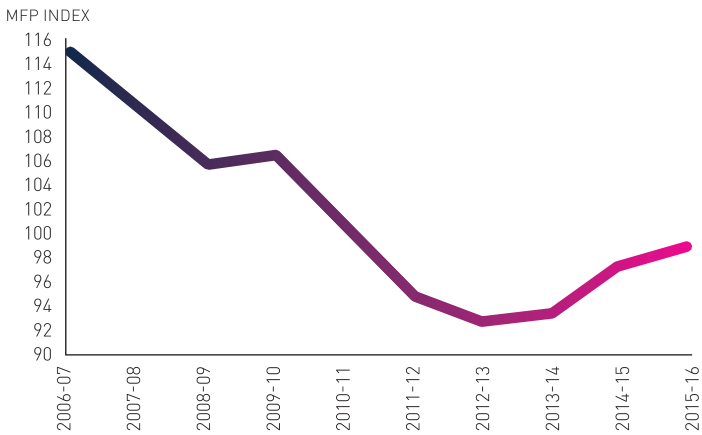
AUSTRALIAN MINING GDP SPLIT % OF TOTAL 2017




*Mining support services include specialist construction, maintenance, transport and rehabilitation services to downstream mining operations, as well as non-exploratory drilling.

SOURCE: ABS

MINING PRODUCTIVITY INDEX MULTIFACTOR PRODUCTIVITY** 2006–16




**Multifactor productivity (MFP) is defined as a ratio of a measure of output to a combined factors, for example labour and capital.

SOURCE: ABS

## Industry Overview

Mining has been one of Australia's most important industries since the mid-1800s, with a number of mining booms driving wealth and population growth. Currently, mining is Australia's fifth largest industry, contributing 6% to total GDP (2017). Despite its importance, in 2018 the industry only employed 2% of the country's total workforce.

The Australian mining sector is technologically advanced and attracts international investment. Its success is linked to Australia's abundant resources, stable economy, highly skilled workforce, first-world safety regulations, and the importance placed on mining research by successive governments and businesses. Mining has laid the foundations for Australia's sustained economic growth.

Industry growth is driven by overseas demand, which also drives commodity prices, and the exchange rate of the $A. The global supply situation is also critical as Australia competes with other mining nations for market share.

Mining comprises 41% ($127 bn, 2015–16) of Australia's export revenue, making the country the world's fourth largest mining exporter, predominantly in iron ore, coal, natural gas, gold and aluminium.[40] [41]

## Trends

**Costs have increased** significantly over the past 10 years (ratio of total expenses to total income has risen from 67% in 2006–07 to 95% in 2015–16).[42] Many of the larger mining companies have already made significant productivity improvements and reduced costs, in part through the use of the IoT during the last period of declining commodity prices in the early part of this decade.

However, true 'comprehensive' IoT solutions have only been rolled out at scale in selected mines; less progress has been made at smaller scale operations.

**Key resources prices:** Iron ore and coal prices are notoriously volatile. While it is difficult to create precise long-term forecasts, every boom has historically been followed by some reduction in commodity prices, and the World Bank is expecting a drop over the next 10 years or so.[43] When the inevitable next cycle hits, the industry will move down the mining cost curve and all mines, particularly smaller less efficient mines, will need to seek productivity improvements and innovation to remain viable.

**Alternative energy:** For coal, the long-term outlook is also influenced by the application of alternative energy both in the domestic market but probably more significantly overseas. As other countries are increasing their share of alternatives in the energy mix, Australian coal may come under pressure, further increasing the need for efficiencies.

**Supply constraints** will only ever increase due to the finite nature of most mining commodities. The mining industry needs to work ever harder to maintain outputs. Mining companies must find more efficient ways to identify, develop and operate reserves.

**Safety regulations** are likely to continue to increase as new technology becomes available.

**Environmental impact** will remain a focus and may increase the difficulty of obtaining approvals for future projects, which in turn could reduce supply.

## IoT Opportunity: Mine of the Future

Similar to the construction industry, mining involves a large number of machines and other technical objects having to collaborate to achieve an outcome. Activities are repeatable (e.g. transport, excavation, moving materials) and not dissimilar from mine to mine. These characteristics make mining a fertile ground for impactful IoT solutions.

Given the significance of mining in the Australian economy (particularly our trade balance), and considering the recent decline in productivity and uncertainty about commodity price growth, there is both a need and an opportunity to improve mining productivity through the automation of repeatable tasks and through the use of data to improve decision making.

Sensors provide real-time visualisation data of assets and the environment, optimise labour and asset allocation, monitor the condition of equipment and enable real-time collaboration across the mining process. The use of autonomous vehicles (e.g. excavators, drills, trains) further reduces labour requirements, improves safety outcomes and increases precision. The high volume of data made available can improve the efficiency of exploration and better direct mining activity through an improved mine profile.

The use of IoT technology can improve the efficiency and effectiveness of mining operations. Not only can an individual mine be optimised across the entire spectrum of operations, but long-haul transportation, including port operations, can be automated and optimised as well. Should the incumbents be able to directly link predictive demand and supply models in real time with the end-to-end, optimised and dynamically reacting supply chains from not only one but a number of integrated mines to port, the benefits would be enormous.

### Impact Summary

**Total benefits:** $22–34 bn

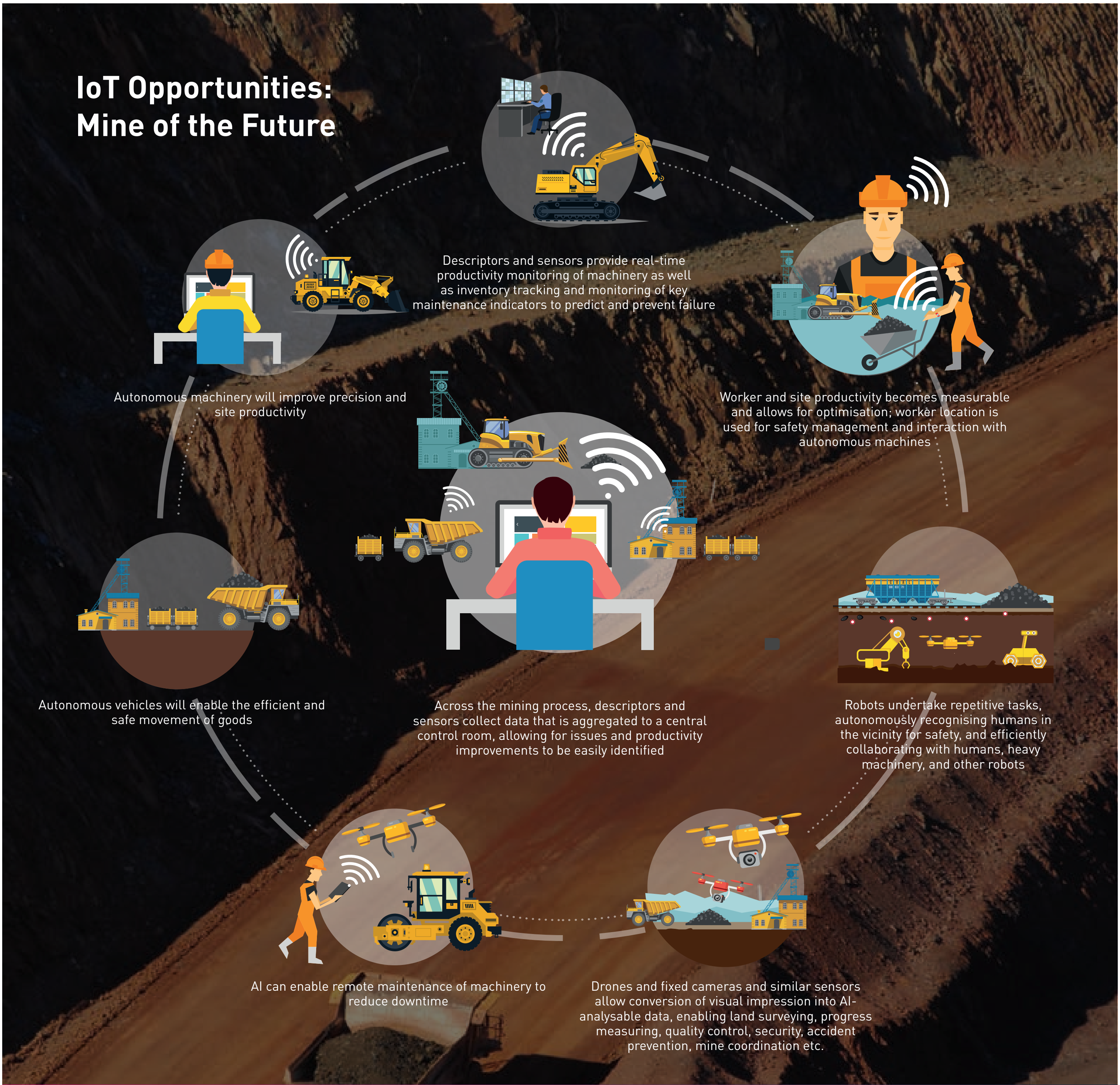
The IoT has significant potential to increase output, decrease production cost, improve safety outcomes and reduce environmental impact across the mining sector.

We estimate that the benefits of the IoT could reach $22–34 bn (18–27%) as a result of autonomous machinery, reduced energy, maintenance and labour costs, and real-time or even predictive end-to-end supply chain optimisation.

This improved efficiency would aid in Australia's GDP growth by helping shield the industry from often externally driven commodity price fluctuations and allow increased competitiveness in the global export market. Although there is some innovation in this industry, and large players such as Rio Tinto and BHP have already started rolling out various IoT solutions, these developments have taken significant time to implement at scale, given the extent of operations and the business, safety and environmental implications of failure. For example, Rio Tinto's autonomous train took six years to deliver.

Challenges for an accelerated IoT implementation include a potential lack of a burning platform with commodity prices trending upwards, as well as a decentralised operating structure and limited 'willingness to change' on individual mine sites.

# IoT Opportunities: Mine of the Future




Current example use cases

**Rio Tinto** is developing a heavy-haul autonomous rail system to launch by the end of 2018. Trips will be able to be completed without a driver on board, thus reducing labour requirements, but will be monitored in real time from an operations centre. Trains are also equipped with AI technology that can assess topography, the curvature of the railway and carriage weight factors, enabling the train to be driven 20% faster than humans with 13% greater fuel efficiency.[44] [28] Ultimately it will become part of a multi-mine IoT-enabled and optimised supply chain from mine to port.

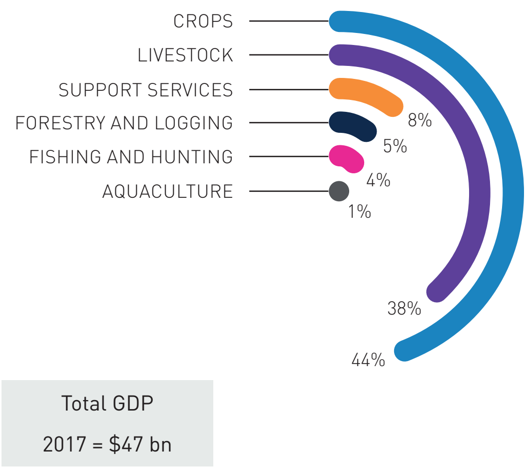
**BHP** has implemented an autonomous truck system that allows for the movement of materials more safely and efficiently with reduced labour. Operated by a supervisory system and central control, the trucks use a pre-defined GPS route to navigate roads and intersections automatically and to detect the location, speed and directions of other vehicles at all times.

**Airobotics**, an Israeli company, has introduced fully autonomous drones to the Australian mining industry. The drones collect aerial data at open-pit sites and can perform various tasks, such as land surveys and security surveillance, enabling better situational awareness and emergency responses while at the same time reducing the need for human labour and improving safety and efficiency.

# Agriculture, Forestry and Fishing

- Total revenues: $101 bn[10]
- GDP: $47 bn, 3% of total GDP in 2017, 4% CAGR 2014–17[5]
- Employment: 325,000 people (3% of total employed, -1% CAGR 2009–18)[11]
- Composition and productivity:

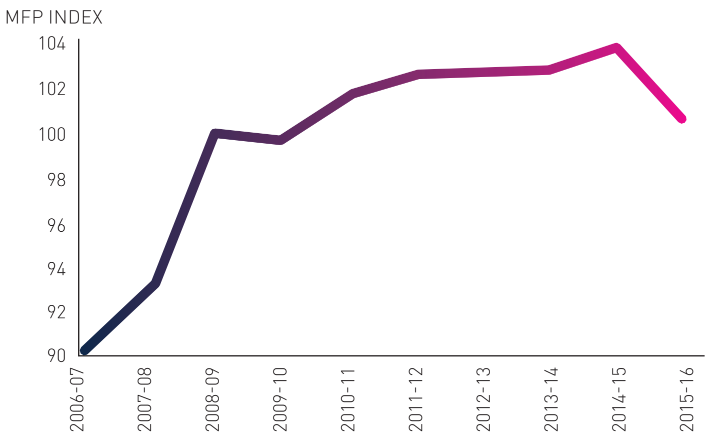
AUSTRALIA AGRICULTURE, FORESTRY AND FISHING GDP SPLIT % OF TOTAL 2017




Note: Excludes the value of exports, % splits are based on 2015–16 data

SOURCE: ABS

AGRICULTURE, FORESTRY & FISHING PRODUCTIVITY INDEX MULTIFACTOR PRODUCTIVITY* 2006–16




*Multifactor productivity (MFP) is defined as a ratio of a measure of output to a combined input of multiple factors, for example labour and capital.

SOURCE: ABS

**Exports**

Valued at $43 bn (14% of total exports, 7% CAGR 2011–17). The world's 16th largest food exporter.[45]

## Industry Overview

Agriculture continues to play a vital role in the Australian economy, with farmers producing 93% of the nation's domestic food supply.[46] Not only is agriculture the biggest employer in rural and regional areas, it is also the third largest export sector after mining and manufacturing.

Australia is well endowed with suitable geography for agriculture. The country's large land size and small population provide one of the highest 'arable hectare to person' ratios in the world and ample room to farm. There is also diverse soil and climates across the country that allow for a variety of fresh food and fibre to be produced all year round. Also, Australia's isolation means it is less affected by air pollution, which improves its ability to grow high-quality produce.

Increasingly, agriculture is considered a driver of the next wave of growth for Australia; some speak about a shift from 'the mining boom' to 'the dining boom'. Also, the sector is expected to lead Australia to the next level of engagement with Asia, where a rapidly growing middle class is increasingly demanding higher quality food, with Australian produce well positioned.

## Trends

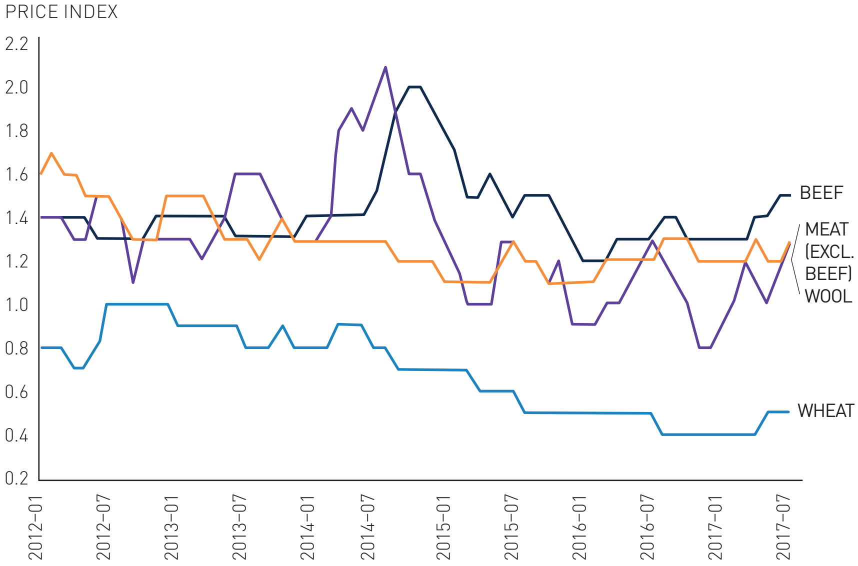
While export growth, in particular, appears favourable, driven by significant demand in large, high-growth markets, the sector remains challenged by a number of factors.

**Commodity prices** are trending down, while costs are increasing and putting pressure on profit margins (goods and materials purchases as a percentage of total income increased by 5% from 2013–14 to 2015–16), which is, in turn, creating a severe labour shortage (employment -1% CAGR 2009–18).[10]

**Climate change** is influencing the intensity and duration of rainfall, which in turn is leading to fluctuations in yield and increased uncertainty and making some farms unsustainable.

**Competition for key exports** will continue to intensify. Exports from South America (e.g. Brazil has become the world's largest beef exporter)[47] and Eastern Europe (e.g. Russia and Ukraine have affected Australia's wheat trade to Indonesia)[48] have continuously increased their share of global agricultural export markets over the past 15 years.[49] Investment in infrastructure and technology, such as the IoT, will be crucial over the coming years to reduce costs and protect Australia's competitiveness.

AUSTRALIA'S TOP AGRICULTURAL COMMODITY EXPORTS PRICE INDEX 2012–17




Note: Index month is April 2018.

SOURCE: INDEXMUNDI

## The IoT Opportunity: Smart Farms

Australia's agriculture industry is comparatively homogeneous, with more than 80% of the sector's activity driven by farming, either crops or livestock. Compared to some other industries, operating a farm is a somewhat more repeatable process. Also, farming involves a high degree of manual activity, much of which has not changed significantly over time, and IoT solutions appear particularly well positioned to drive a step change in productivity.

'Smart farming' refers to a concept of farm management that leverages digital technology to increase the efficiency and effectiveness of agricultural processes, which in effect become more 'factory' like. Through the use of sensors connected to a system, farmers can closely monitor, in real time, the environment and the health of their crops and livestock. Assets (e.g. irrigation systems, drones, autonomous vehicles, gates) can be connected to a central system and deployed and controlled remotely or be automatically set to monitor and respond to changes in the environment as required. The use of autonomous vehicles, robots and drones can automate previously manual processes and overcome the distance problem, which is particularly challenging in Australia, and drastically reduce the level of required labour. Lastly, but perhaps most importantly, the availability of significantly more data, not only about an individual operation but about numerous farms in the area, the country or even the world, will provide insights into measures to improve yield and profitability. This integrated system of assets would ultimately allow one or more farms to be controlled largely from a farmer's connected device, with limited need for physical human intervention.

### Impact Summary

**Total impact:** $14–22 bn

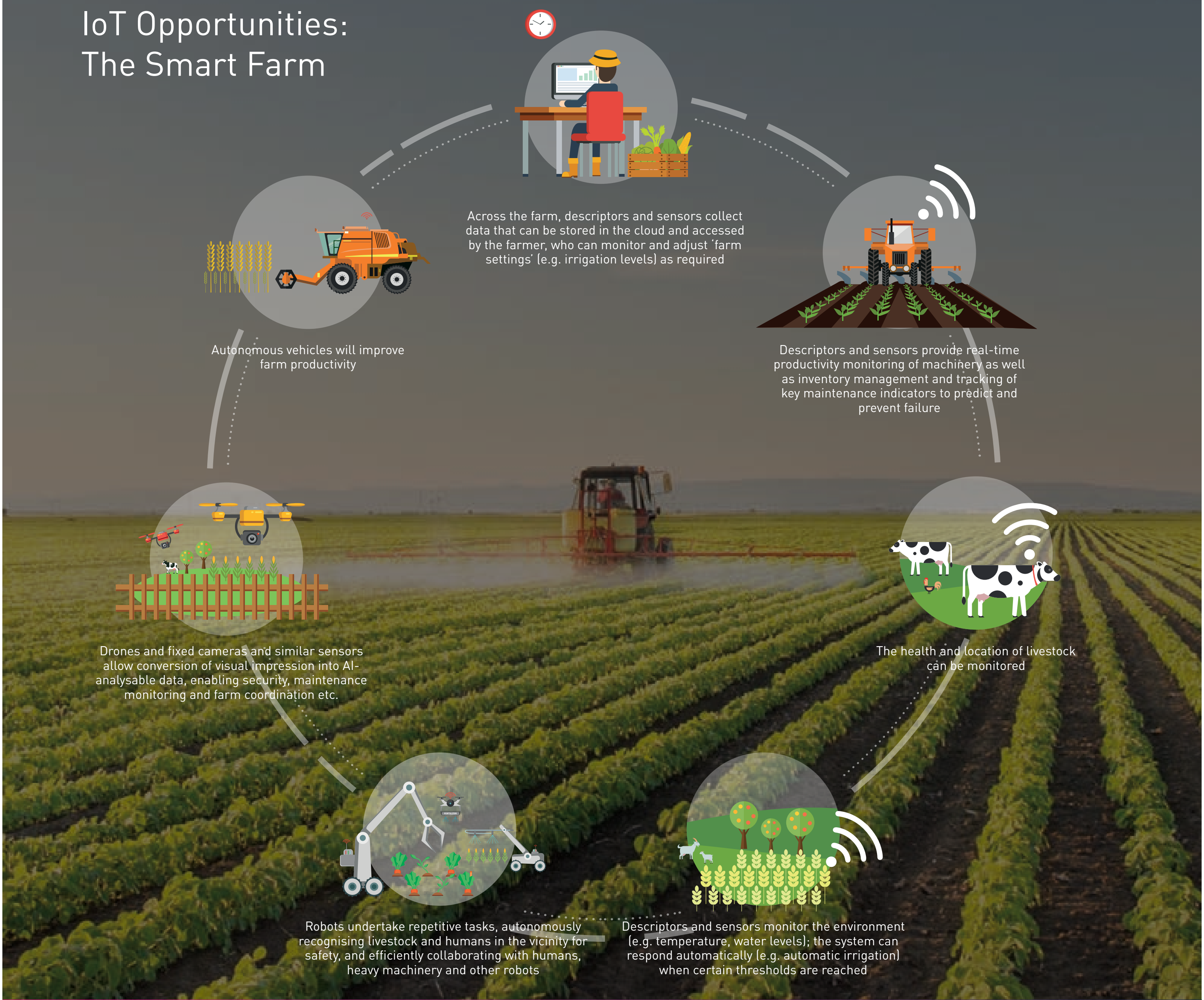
Smart farms have the ability to both increase yields and reduce operating costs. We estimate that IoT solutions across the industry could deliver annual benefits of $14–22 bn (20–32%) through improved crop and livestock yields, reduced wastage and livestock mortality, operational process improvements, and maintenance and labour cost savings.

This impact of the IoT would significantly increase the competitiveness of one of Australia's key export sectors. It would also improve the cost of living for most Australians by lowering the cost of domestically produced food.

Innovation is critical in the agriculture sector because expanding production will not be easy without significant increases in efficiency and yield, given the shortage in labour, fluctuating productivity and the continued rise of input costs.

Currently, there is a shift occurring in the industry, with the next generation of farmers moving into decision-making positions. The next generation is technologically savvy and open to innovation and change. IoT solution providers report good, collaborative access to the industry, in part driven by several supportive industry associations. A significant challenge for agriculture – more so than for other industries – is the appropriate communications infrastructure to support the growth of the IoT, such as access to the internet in remote areas.[52]

# IoT Opportunities: The Smart Farm




## Current example use cases

**Hitachi** is developing satellite-positioned drone technology to accurately pinpoint weeds that can be geotagged for automatic spot spraying at a later date. This will reduce both labour and the amount of chemicals required to kill the weeds.[50] Other drones under development are providing patrolling flights to autonomously identify maintenance issues, often saving multi-day field trips for inspections.

**Monsanto**, a multinational agricultural biotech company, has developed a digital farming platform, Climate FieldView. This platform allows farmers to make data-driven decisions to maximise yield through collecting and analysing field data, measuring performance, monitoring nitrogen, and building tailored seeding prescriptions. Users of Climate FieldView have increased yields by around 5% over two years, and this is expected to increase to up to 25% for some crops (e.g. maize) as more farms are signing up and more data becomes available.[51]

**Fujitsu** has developed technology to predict and alert farmers when cows are ready for breeding through pedometers connected to a receiver through radio signals. This would reduce the amount of manual guesswork farmers often undertake, such as visual observation, and improve yield.

**Smart Ag** in the USA has released the world's first cloud-based platform for driverless tractors. The system automates existing grain cart tractors and allows an operator to set staging and unloading locations, adjust speed, monitor location and command the grain cart to sync precisely to the speed and direction of the combine harvester.

## Conclusion: Economic Impact of the IoT

# 2%

## PRODUCTIVITY INCREASE PER ANNUM DRIVEN BY THE IoT

The five industry sectors covered in this report represent approximately 25% of Australia's GDP. The IoT can achieve potential benefits of $194–308 bn (17–28% of the cost base) over a period of 8–18 years, depending on the industry. This translates into average productivity improvements of around 2% p.a. across those industries, a significant improvement that will help support Australia's growth aspirations while also reducing reliance on natural resources.

Domestically, such an improvement would help improve living standards, allow for improved health and safety outcomes and reduce environmental impact. Critically, it would help make Australian companies future fit and competitive. They would be better able to compete domestically with international entrants and be significantly more competitive abroad, thereby improving the balance of trade and making Australia a more important player globally.

These impacts will be significant also in terms of the employment profile of those industries, with smaller workforces required to achieve the same output. However, given the time it will take to realise maximum benefits across these key industries, the shift in employment will be gradual and in most cases can be managed through natural attrition and re-skilling as well as rising outputs in industries such as agriculture and mining, or improved service levels in industries such as health.

Demand for highly skilled jobs will increase. A substantial portion of the projected IoT-related ICT industry growth (described in Chapter 4) represents newly created highly skilled IoT jobs, and startups and incumbents will add to those numbers. As such, the move into the IoT age will allow industries that are currently traditionally driven by semi-skilled labour to transition to a future highly skilled world.

| | Change management | Scale/ fragmentation | Limited demand pull | Limited pressure to change | Geographic remoteness | Estimated years to implement maximum run-rate benefit | Comments |
|---|---|---|---|---|---|---|---|
| Construction | High | Medium | High | Medium | Medium | 15 | • Long-term productivity stagnation<br>• Poor record of technology adoption<br>• Workforce resisting change more than elsewhere<br>• Residential construction is fragmented and IoT is less applicable |
| Health | High | Low | High | Medium | Low | 18 | • Significant infrastructure already established and difficult to retrofit rapidly<br>• Deeply entrenched ways of working, with incentive structures hard to change, influenced by significant lobby groups and political agendas |
| Manufacturing | Low | High | Low | Medium | Low | 10 | • In Australia, fragmented and small scale |
| Mining | Medium | Low | High | High | Medium | 15 | • Some adoption of IoT ongoing<br>• Change resistance remains significant<br>• Limited recent pressure to innovate |
| Agriculture | Low | High | Low | Medium | High | 8 | • Fragmented industry<br>• Significant geographical remoteness and dispersion<br>• Industry keen to adopt new technologies |

NEGATIVE IMPACT ON IoT ADOPTION

High Medium Low

# Implementation Challenges

The total potential maximum benefits by industry are theoretical estimates. In some industries, the full potential of the IoT, for a variety of reasons, may take a long time to achieve.

While the key technical challenges and complexities of the IoT remain valid, they are now well documented and understood, and software giants, engineering houses, incumbents and a myriad of startups are tirelessly working to solve them.

Other challenges include industry-specific regulatory challenges, as discussed for each industry above, as well as cyber security challenges, as discussed further in Chapter 5.

However, over the past two to three years, stakeholders have started to realise that other, more structural challenges form possibly the most significant barrier to the IoT rollout at scale.

Such challenges include:

**Limited pressure to change:** In some Australian industries, the pressure to change is currently not very significant. This is driven in part by a potential lack of domestic competition as well as the fact that most industries are not competing very actively in international markets. Of those who are, external factors may drive profitability to such a significant extent that potentially difficult change at home is not perceived as a high priority. For example, the mining industry had substantial success in efficiency improvements once the mid-2000s mining boom had subsided, but has now entered a new phase of increasing commodity prices that may slow investments into further efficiency improvements.

**Limited industry scale/industry fragmentation:** New IoT solutions typically require either a co-development approach between IoT solution providers and incumbents or for incumbents to drive solution development in-house. Making investments in the necessary R&D requires a certain scale. Fragmented industries, where the majority of players are reasonably small and may not have the resources available to either drive or outsource R&D, may struggle to establish new solutions. For example, the agriculture industry is mostly made up of small and medium-sized enterprises that only collectively have the resources to invest in significant R&D efforts. They may, therefore, need to identify different ways of collaborating with solutions providers to drive larger scale IoT solutions.

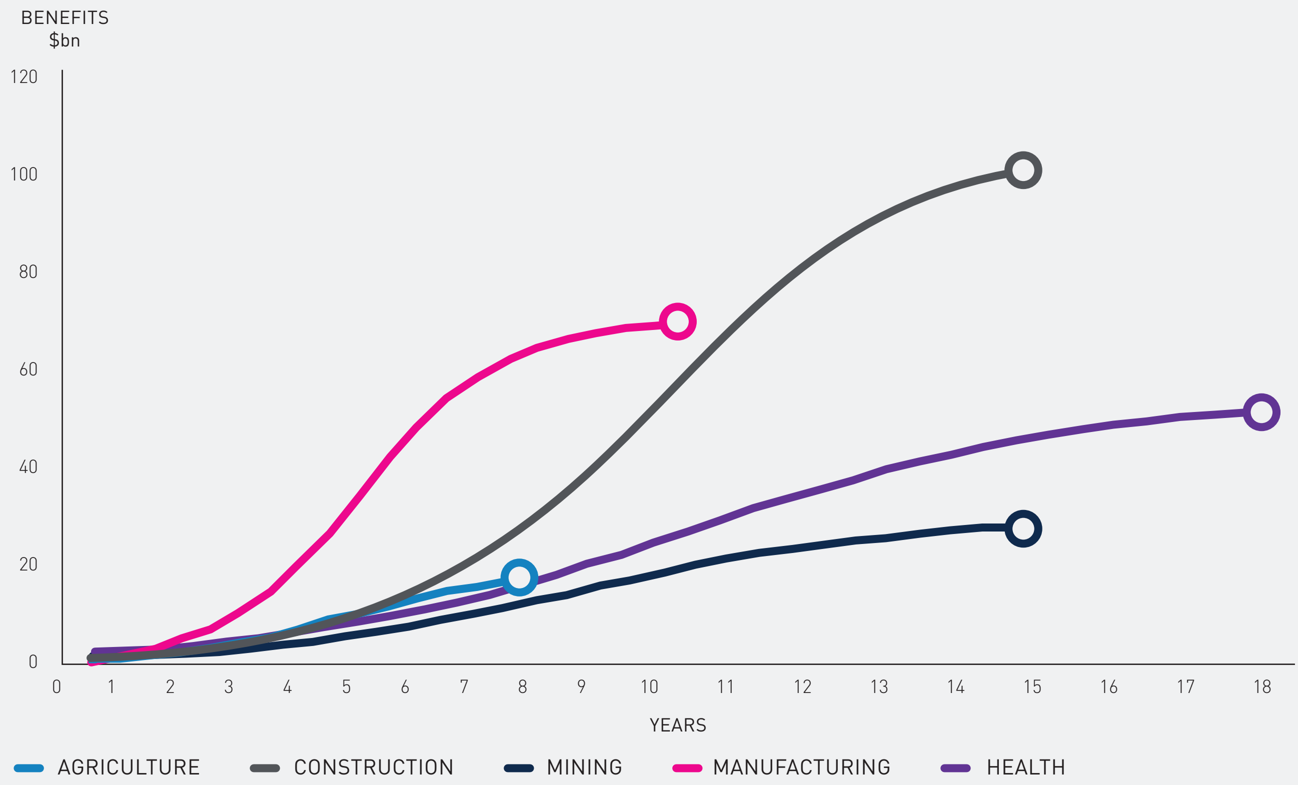
**Organisational change management:** Forming a view on the need to significantly change the way they are working can take large incumbents several years. Once a board or leadership team has made that decision, implementing a new, holistic IoT solution typically triggers a need to undergo a significant transformation. Australian incumbents in many industries are not used to large-scale structural change, and corporate cultures, unions and possibly the supply chain may resist the required change. For example, while the construction industry has achieved a certain degree of product innovation, significant resistance to organisational and structural reform has meant that ways of working, and hence productivity, have changed little in the past 50 years, a timeframe during which other industries have doubled their productivity.

**Limited demand pull:** Typically, innovation follows a strong demand pull. Where the customer does not demand improved products or more efficient processes, innovation is lacking. This can be the case in industries where competition is not very intense, or where the key customer of an industry is government, such as in public health or large infrastructure. Government may lack the capabilities, the structure or the mandate to demand significantly improved products.

**Geographic remoteness:** The geographic situation of Australia presents additional IoT challenges around connectivity and power delivery for some industries that may need to operate in remote areas, such as mining or agriculture. For example, while there is mobile network coverage for over 99% of Australia by population, there are significant gaps in geographic coverage in regional areas. Similarly, transmission of conventional power is limited by distance. From a purely technical perspective, these challenges are not insurmountable. Connectivity solutions can include low power wide area networks (LPWAN), satellite, boosters, or collaborative local investment in infrastructure. Power delivery solutions can include micro-grids with localised renewable power, battery power or small conventional generation power. However, these connectivity solutions can significantly drive up the cost of implementing IoT solutions and at times require suboptimal workarounds that limit the potential outcome.

We have assessed these challenges in the Australian context and modeled an IoT adoption curve for the five industries considered in this report.

BENEFITS BY INDUSTRY ($BN)




Note: Benefits are mid-points of the estimate range

SOURCE: PWC STRATEGY& ANALYSIS

# Growing the IoT Industry in Australia

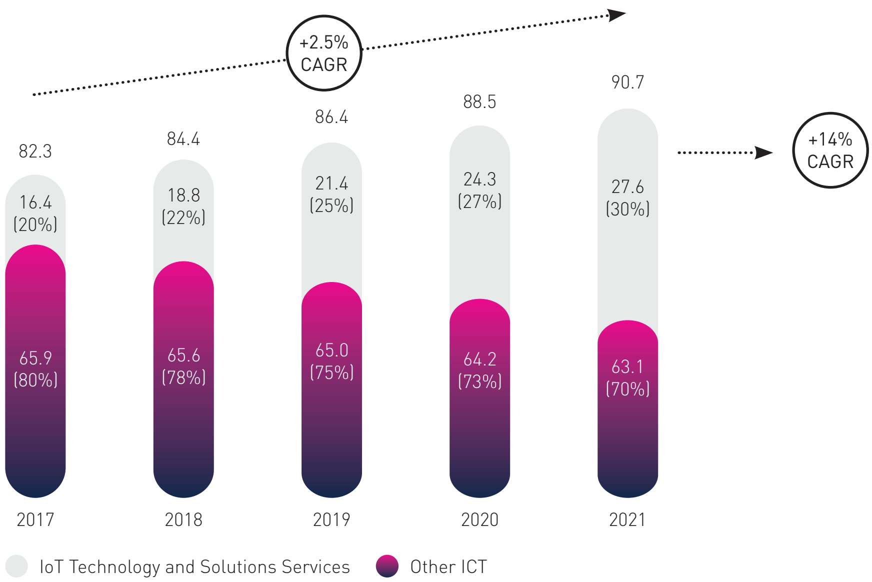
04

In addition to the significant value created through the application of its solutions, the IoT ecosystem represents a sizable and fast-growing industry in and of itself. The value of sensors and actuators, backbone capacity, apps, associated network bandwidth and the broad array of services available has already almost reached A$19 bn, representing 22% of the current ICT market in Australia.

But unlike the overall ICT market, which is only increasing slightly faster than GDP, IoT-related products and services are growing at a significant 14% CAGR, and are expected to reach close to A$30 bn in five years' time, representing almost 30% of Australia's total ICT spend.

The IoT ecosystem can be broken down into its core market segments, and we have analysed the size, growth, current stakeholder composition and strategic trends of these segments. Our analysis allows conclusions to be drawn about the role Australian companies can play within this ecosystem, and what Australia can do to ensure it enables and supports this young industry to blossom.

AUSTRALIAN IoT ICT MARKET SIZE
AUD$ BN 2017–21



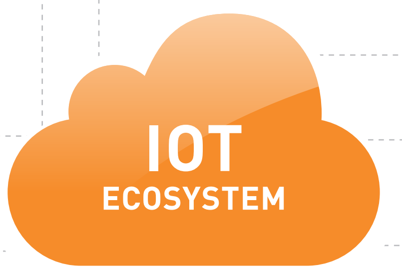

SOURCE: IDC, GARTNER STRATEGY& ANALYSIS

## IoT Backbone

The capture and storage of raw data received from the connected 'things' and the data processing, storage and management of this data. Data processing includes aggregation, processing and management of asynchronous data and real-time data from connected 'things'. Data storage includes storage infrastructure (cloud, servers, data centres) that can accommodate zettabytes of unstructured data.

## IoT Hardware

Sensors, actuators, instruments and other components that capture and relay contextual and real-world data and enable the 'thing' to communicate with its environment.




## Communication and Networking

**Specific network hardware, protocols, software and services that connect underlying IoT hardware to the internet, including:**

Backhaul connectivity – long-haul communication over cellular, GPS, cable, or low-power wide-area networks (LPWANs).

Local connectivity – short-range and machine-to-machine communications, e.g. WLAN, mesh networks, Bluetooth, etc.

IoT gateways – intermediaries between the cloud and sensors/actuators to process the collected data locally before sending it to the cloud.

## Things

Machines, equipment, devices and other physical assets to which IoT hardware is applied, allowing them to sense and affect the surrounding physical environment, receive and transfer data and interact with control units and other enabled 'things'.

## Solution Services

Services that enable users to integrate the components of the system into the relevant business and physical environment and customise it so that it is readily accessible and actionable. These services include consulting and solution development, platform development, device development, vertical application development, systems integration, testing, managed services and support.

> IoT-related products and services are growing at a significant 14% CAGR, and are expected to reach close to A$30 bn in five years' time.

# IoT Hardware

## Market

Estimated Australian market size

$6.1 bn (2021)

~10% CAGR (2018–21)

## Key Players

The vast majority of IoT hardware used in Australia is imported from Europe and the US and, at times, North Asia.

**IoT Platforms**

Support software that provides a 'common language' and connects the various other elements of the IoT ecosystem to each other and the broader value chain, including the end-user applications.

**Applications**

**IoT applications that provide business intelligence/insights to users, including:**

*Enterprise and Consumer Apps* – applications that leverage IoT data and algorithms to solve specific business problems or consumer needs

*Analytics* – advanced analytics solutions that can aggregate, analyse and package data from a broad and diverse range of sources to extract insights.

**Identity and Security**

Encompasses software and hardware across the entire IoT technology layer to enable multifactor identity, authentication management and end-point protection.

Traditional global ICT hardware vendors such as ARM and Intel provide components that power the IoT, while vendors such as Eurotech and Dell provide vertical solutions (i.e. inclusive of software and analytics). More specialised IoT hardware, such as for industrial applications, are often provided by the R&D departments of large industrial players like Siemens and GE. There is also a small but rapidly growing number of startups, including from Australia, that are developing specialised sensors, albeit for very specific niche applications. For example, Smart Paddock is developing a small lightweight sensor for the beef industry that can track the heart rate, temperature, location and movement of cattle to detect potential health issues.

## Trends

Increasingly, actuators and sensors are being embedded in various smart devices, as 'things' are explicitly designed to function within the IoT. The IoT hardware segment is also rapidly increasing in sophistication in terms of processing power, battery life and sensor capabilities. At the same time, significant global competition and advances in manufacturing, but also increasingly scale, have significantly reduced the prices of these components over the last two decades. For example, in 2004 the average cost of a sensor was $1.30; in 2020 it is expected to be just $0.38.[53] As an example of a somewhat more complex IoT hardware system, digital cameras can now be purchased for $30 and add tremendous value to the ecosystem. We expect increasing sophistication and eroding prices to continue, quickly driving commoditisation of the IoT hardware segment.

## Implications

- Companies with a traditional focus on sensor and actuator design, or even entirely enabled 'things' but without the broader IoT ecosystem around them, are finding themselves under pressure as the value proposition rapidly moves towards the software and AI elements of an IoT system.
- The IoT hardware market is well served by overseas players. With Australia's engineering and manufacturing base limited in terms of skills and scale, focusing on IoT hardware design and manufacturing at scale is not likely to be a successful strategy for Australian stakeholders.
- There may, however, be a 'right to win' for local startups and some incumbents in the development of specific IoT hardware that supports industries where Australia has expertise (e.g. agriculture, healthcare) or global scale (e.g. mining), as local collaboration with those players could create competitive advantages.
- Australia needs to enable quick and easy access to overseas IoT hardware to limit any potential delays in IoT applications. For example, the Australian frequencies assigned to z-wave, the broadly used home automation standard, are different from those in the US and Europe where most sensors and actuators are being designed, which can result in slower rollout in Australia.

**Market Categorisation:**
fragmented, internationally served

# Communication and Networking

## Market

Estimated Australian market size

**$4.2 bn** (2021)

**~10%** CAGR (2018–21)

## Key Players

The underlying technology that connects the IoT, both in Australia and globally, is predominantly provided by multinationals such as GE, Intel, Cisco, Ericsson, Siemens and Microsoft. There are, however, some small Australian players; Morse Micro, for example, has developed a Wi-Fi chip that is cheaper, more powerful and five times smaller than conventional IoT Wi-Fi chips. Connectivity technologies vary by range, data processing capability, cost, energy consumption and other factors. Examples include Bluetooth (short-distance), Wi-Fi, cellular and non-cellular LPWAN, cellular wide-area networks (WAN), satellite and many more.

Communication services and network providers leverage the technology provided by the equipment players to process, control and manage the IoT network traffic. Overseas, there are many connectivity options available across the different network types. Sigfox (France) has the world's largest network footprint, which has been rolled out in more than 60 countries using local operators. Sigfox, as well as their competitor LoRa, uses LPWAN technology, which enables simple, low-powered, low-cost connectivity.

Telstra and Thinxtra (the Sigfox licensee in Australia) are currently the leading IoT connectivity providers in the Australian market, with Telstra presently dominating given the strong coverage advantage of their 4GX cellular footprint. All major mobile operators in Australia have rolled out narrow band IoT technology for LPWAN across major cities, with Telstra having the most extensive footprint and commercial success. Telstra and other players are also rolling out 5G, which provides higher speeds, lower latency and a larger number of connections, which will better support the IoT. Thinxtra is a major non-cellular player and is rolling out a developed ecosystem in Australia with multiple low-cost device options using Sigfox's technology. NNNCo, Meshed and Definium are other up-and-coming alternatives that also provide connectivity using LoRa (long-range) technology.

## Trends

Currently, given the limited options available, the choice of IoT network provider is likely to be a company's current mobile provider or the least expensive alternative. However, the choice will significantly broaden as the IoT develops in Australia and the number of network types increases. Network requirements in terms of speed, data volume, power consumption, range and other factors will drive decision making.

Cost will become an increasingly important factor in the choice of vendor, as IoT expenses become a larger part of the bottom line. This may become particularly critical once the IoT extends from the current 'heavy IoT' space, with hundreds and thousands of connections, to the 'light IoT', with potentially several hundred thousand connections (e.g. individual bees to monitor agriculture efficiencies). Reliable service provision will become another critical factor as outages become more costly as adoption increases. Overall, choice is likely to broaden, as technology develops.

## Implications

- The wide range of available technologies is already increasing choice for the customer. While large local incumbents remain well positioned, the ability to use unlicensed spectrum opens up opportunities for new entrants – both international players that can leverage advanced overseas models as well as agile local startups.
- Local startups may be able to carve out a niche in areas where Australia is unique compared to other parts of the world, such as remote and difficult to access areas. They may also be able to collaborate better with some players in health where Australia is a leader.
- Core communication hardware is likely to continue to come from overseas providers given the significant R&D budgets required to develop the underlying technologies. However, domestic players may be able to create localised solutions for the edge and other adjacent solutions.

**Market Categorisation:**
concentrated, locally served*

*Locally served includes local delivery of internationally developed solutions

# IoT Backbone

## Market

Estimated Australian market size

**$1.0 bn** (2021)

**~20%** CAGR (2018–21)

## Key Players

The Australian market is currently served by large multinational vendors such as Amazon, Microsoft, IBM, Google, Oracle and Samsung, which tend to provide reasonably generic solutions. There are also IoT network providers such as Vodafone and Telstra as well as business platform providers that offer cloud services within their integrated vertical solutions, but these are usually tailored towards a specific industry area. A few Australian startups also operate in this space, typically complementing a core service offering around other ecosystem elements with cloud-related services. Solutions tend to have common features, with some offerings performing better in specific areas.

Realising that cloud services are commoditising, players such as Microsoft are attempting to differentiate themselves by offering adjacent services such as machine learning data analytics, while other players are offering tailored services to specific industries; Oracle, for example, targets manufacturing and logistics.

## Trends

Cloud solutions are becoming more cost-effective and easier to deploy. They are also increasingly an add-on to more vertically integrated customer offerings. Demand for cloud services is forecast to increase due to the influx of data that IoT adoption will drive. Cisco predicts that total data stored in data centres will increase fivefold between 2016 and 2021 due to the IoT. Cloud providers are looking for ways to improve the efficiency of data processing through the use of edge computing, which allows some data to be stored and processed locally, thus reducing data traffic.

Delivery of services will continue to be provided mainly through SaaS (Software as a Service), which is forecast to account for 75% of all cloud storage compared to 71% today. PaaS (Platform as a Service) will increase from 8% to 9% despite having been previously forecast to become redundant.

'Hyperscale' data centres are also forecast to take over as the basis for cloud infrastructure, increasing from approximately 25% of data centres today to more than 50% by 2021.[54] These centres, of which the majority are located in the US, have large-scale computer resources that essentially allow uncapped scalability for hosted applications and services.

While some majors dominate, the global market is currently considered complex and over-crowded. Nevertheless, further consolidation is expected, with Amazon, Google and Microsoft predicted to account for 80% of cloud revenue by 2020.[55]

## Implications

- Cloud – in itself – is going to be a difficult market in which to compete for Australian players.
- Startups can cooperate with cloud majors to establish specific supplementary services and solutions and go to market together, or provide add-ons.
- Larger incumbents can offer specific niche solutions for industry verticals where cloud services are part of the integrated solution.

**Market Categorisation:**

concentrated, internationally served

# Enablement Platforms

## Market

Estimated Australian market size

**$0.5 bn** (2021)

**~20%** CAGR (2018-21)

## Key Players

The global and Australian markets are currently served by large multinationals such as Amazon (AWS), Microsoft (Azure), Google (Cloud Platform), IBM (Watson), Samsung (Artik), Cisco (IoT Cloud Connect), HP, Salesforce and Hitachi, all of which offer relatively generic solutions, aiming for scale and network effects. There is also a large and growing number of other stakeholders providing various types of more specialised IoT platform solutions. Currently, these players are predominantly enterprise software and services companies as well as technology, internet and telecommunications organisations and startups.

**Market Categorisation:**

concentrated, internationally served

## Trends

The platform market is still considered immature, evolving and dynamic, characterised by partnerships and M&A activity. It is anticipated that it will remain competitive and fragmented in the near-term, with those platforms that are open, provide scalability and are user and developer friendly being the best positioned. In the long run, it is expected that some players will be forced out of the market or merge with other providers as leaders seek further scale or to fill capability gaps. However, new entrants will likely persist, driven by an attempt to gain market share in the more lucrative up-stream technology layers such as applications and analytics.

Increasingly, this area of the value chain will be bundled with up-stream (e.g. applications) and down-stream customer offerings (e.g. cloud storage and connectivity). Eventually, offerings will become increasingly integrated ecosystems for customers who want end-to-end solutions without having to piece together a system or build from scratch.

Larger incumbents, including those in Australia, are also working on specific platform solutions for their respective markets. For example, Lendlease is working on a 'Smart Cities' platform that will enable holistic data collection, processing and analytics and enable future IoT solutions; Ventia is working on a platform that will allow it to integrate the IoT with its holistic workforce management tools.

The use of AI and machine learning is also expected to become an increasingly common platform feature, as players seek to not only differentiate themselves in a competitive market but also enhance performance. GE's Predix Dojo approach is an example of how platforms are becoming increasingly open to improve collaboration with in-house developers and increase the speed to market for proof of concepts. Unsurprisingly, security is also becoming an increasingly important element of platforms.

## Implications

- As platforms mature, they are becoming a standard within the IoT world and hence a key competitive advantage for those who control them. They will also be the underlying tool to integrate other parts of the ecosystem.
- Australian players can establish their niche applications and may be well positioned if they can forge the right alliances to create a sustainable position.
- If successful, there may be the opportunity to export those solutions to other markets.

# Applications

## Market

Estimated Australian market size

$6.2 bn (2021)

~30% CAGR (2018–21)

## Key Players

The applications market is currently highly fragmented. At a global level, manufacturing industries had a head start in IoT solution implementation, initially driven by the large engineering houses such as GE, Siemens and Bosch. Large technology players followed, with Amazon and Google offering consumer-driven solutions and Microsoft and IBM leveraging their broad software capabilities. All these players are now competing in Australia with a diverse range of value propositions. However, a rapidly increasing number of startups, both globally and locally, are starting to offer innovative, although typically specialised, solutions.

In Europe and the US, some sectors are starting to see concentration. However, the Australian market requires somewhat different solutions and the playing field is still wide open, with the above industry giants, large incumbents and nimble startups all still finding their positioning.

## Trends

Applications are rapidly becoming the key value driver of IoT ecosystems. With few significant barriers to entry, it is likely that the number of players in this market will explode in the coming years. Competition and collaboration between software and engineering powerhouses, incumbents and startups will intensify. Winners will not necessarily be the biggest players but those who can best match their solutions to market requirements and either work with incumbents to disrupt current ways of working or establish solutions that can quickly scale and make new markets. Also, the applications market is the part of the IoT ecosystem that is most resilient to commoditisation.

## Implications

- Application development, if coupled with the appropriate technology partnerships and sustainable business models, allows small and new players to leapfrog decades of engineering know-how and, within a reasonably short period, develop solutions that can deliver enormous value to customers.
- For Australia, this offers an opportunity to circumnavigate some of the disadvantages associated with the country's limited participation in other elements of the IoT ecosystem.
- Australian incumbents need to learn to cooperate with more nimble startups to make rapid progress in IoT applications.
- Australia is relatively strong in software development, suggesting that with additional investment and support, there is potential to develop sophisticated and valuable IoT solutions, some of which could be exported.

**Market Categorisation:**

fragmented, both locally and internationally served

# Identity and Security

## Market

Estimated Australian market size

**$1.4 bn** (2021)

**~30%** CAGR (2018–21)

## Key Players

Cyber security risk is rising just as fast as the number of internet-connected devices. Consequently, the number of companies focused on IoT security is growing quickly as well. The IoT security market is an aggregation of innovative startups, established firms such as global chip manufacturers, infrastructure providers, and cloud and enterprise software companies. Cisco is the current market leader in the fragmented IoT security market, with an estimated market share of 7%. The top 10 providers account for over 40% of the IoT security market.[56]

In Australia, those players are all present, and often have significant competitive advantages as they can bundle security solutions with other IoT elements, or have brand power in the security space. Nonetheless, the number of homegrown Australian startups is rising rapidly, taking advantage of the fact that Australia is punching above its weight in the cyber security space. According to the United Nations International Telecommunication Union (ITU), Australia is a 'leading nation', having attained the equal sixth-highest Global Cybersecurity Index (GCI) score.[57]

Companies such as Cog, which works with global device manufacturers to help them build better security resilience and richness into the products they are building, or SIEMonster, which provides IoT security monitoring, are carving out their positions.

## Trends

Growth in the IoT-related cyber security space will be significant. In fact, it may well be the fastest growth area for some time to come, given the over-proportional increase in risk as additional 'things' are connected.

As IoT hardware and other elements are increasingly designed explicitly for the IoT age (as opposed to the current situation where many devices are retrofitted), cyber security is progressively built into the system, improving the competitive position of large IoT players that operate across the entire spectrum of IoT elements.

Opportunities for niche players and startups exist, particularly in industries that are less penetrated by the IoT. For example, the further one moves away from manufacturing and industrial solutions, which have traditionally been the lead industries in the cyber security space and where the development of solutions has been the strongest thus far, the greater the opportunities.

## Implications

- Given the country's expertise, the growing importance of the IoT and the currently inadequate security measures, there is an opportunity for Australia to specialise. This will accelerate Australia's own IoT development and could also provide significant export opportunities.
- However, local companies will need to consider how best to take their innovative IoT cyber security ideas to market. They would be wise to consider partnerships with global IoT element players that can accelerate upscaling or large services firms that can act as intermediaries.

**Market Categorisation:**

fragmented, both locally and internationally served

# Solution Services

## Market

Estimated Australian market size

**$8.1 bn** (2021)

**~30%** CAGR (2018–21)

## Key Players

Globally, the market for IoT solutions services is dominated by multinationals such as IBM, Accenture, Tata Consulting Services, Capgemini and SAP. These companies, which have traditionally operated in the broader ICT solutions services market, are seizing the opportunity of the next wave of growth. However, there is also competition from technology firms such as Ericsson and Hitachi, telecommunication firms such as AT&T and Vodafone, as well as professional service firms such KPMG and Deloitte, which are launching or expanding professional services to support IoT solutions development or implementation, given the growth potential of the market.

The situation in Australia is no different, with most of the players mentioned above operating here through their local subsidiaries or franchises. Due to the structure and dynamics of the industry, and the fact that most of these services are currently provided in-country by a local workforce, the value-add from these services, including skills transfer, typically flows through to the Australian economy.

## Trends

As hardware and software technology issues become increasingly manageable, the challenge moves away from the technological solution and towards implementation at scale. This task includes the integration of IoT solutions into the systems and processes of large, medium and small incumbents, and brings with it the associated software integration and organisational change management challenges. With limited capability available in-house at the incumbent players, the solution services market will, therefore, grow faster than the rest of the IoT market and potentially be a limiting factor to overall IoT adoption in Australia.

As the market matures, and enabling technology becomes increasingly mainstream, parts of the solutions services market may be outsourced to lower-wage or higher-skill locations. Future developments and standardisation of dominant IoT platforms will slow the demand for some parts of the segment.

## Implications

- Solutions services will play a significant role in enabling IoT adoption in Australia. Most of the value generated through this segment will remain in Australia. As skill shortages have the potential to slow the growth of this segment significantly, it is critical that an appropriately skilled resource pool be developed to satisfy demand.
- A strong exchange of skills should, therefore, be encouraged, and international expertise welcomed. While exporting Australian capability in this space is unlikely to generate domestic benefits directly, Australia will benefit from the knowledge transfer that international experts can bring into the country.

**Market Categorisation:**

fragmented, locally served*

*Locally served includes local delivery of internationally developed solutions

# Conclusion: Targeted Growth Opportunities

Our analysis of the individual market segments of the IoT ecosystem suggest that large multinational technology heavyweights such as Amazon, Google and Microsoft, as well as the traditional industrial engineering giants such as Siemens, GE, Bosch, ABB and Hitachi, already dominate parts of the IoT ecosystem, including the backbone segment and the platform segment. These areas do not appear lucrative enough to justify a focus on developing Australian expertise to compete with incumbents. Furthermore, IoT hardware is becoming increasingly commoditised, and a broader involvement at scale would likely require improved electronic and manufacturing capabilities.

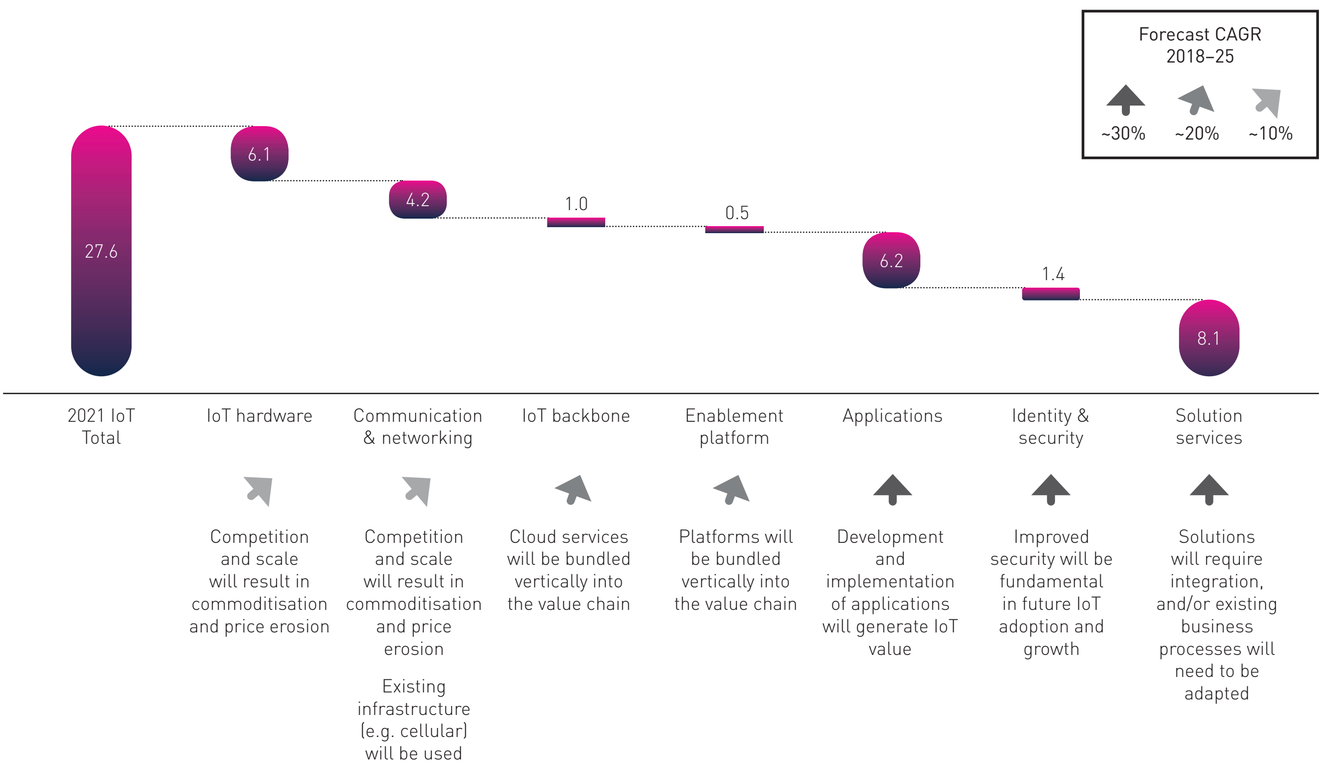
However, there are still significant opportunities for Australian. One is, of course, to accelerate the adoption of the IoT and to increase the value that it delivers to the country's core industries. Another is to capture some of the direct benefits by carving a niche in specific core elements of the IoT ecosystem by:

- Maintaining control of the domestic communication and networking space
- Becoming a global leader in identity and security
- Becoming a global leader in selected applications
- Capturing the value of localised solution services, and enhancing quality and applicability in the domestic market.

Across the other elements of the IoT, namely IoT hardware, IoT backbone and IoT platforms, Australia needs to ensure that we remain rapid followers in the adoption of the solutions developed overseas. We also need to encourage local startups to develop niche solutions, particularly in areas of comparative advantage for Australia.

All stakeholders have a role to play. Government needs to eliminate potential hurdles in the importation and application of those parts of IoT solutions in Australia and provide the appropriate guidance and support to the startup community to direct efforts towards the highest value activities. Incumbents need to develop the capability to quickly and reliably identify which global technologies have the most relevant and enduring local impact on their specific businesses. Incumbents should also improve their capability to identify specific gaps in their IoT ecosystem and collaborate with startups, academia and government to drive local solutions.

AUSTRALIAN IoT ICT SPENDING BY ECOSYSTEM MARKET SEGMENT 2023 (A$ BN)




SOURCE: PWC STRATEGY& ANALYSIS

# Managing Cyber Risks

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Consider the following scenario. Technology is now available to provide life-saving pacemakers for infants that when monitored remotely using the IoT, can inform a physician of the child's vital statistics, and enable device settings to be updated remotely without invasive surgery. In August 2017, Abbott Laboratories discovered vulnerabilities in 465,000 of their pacemakers which included the ability of a third party to remotely access and alter critical functions including speed of pacing. This led to a national recall to update the devices' firmware, a process that, fortunately, did not require surgery for affected patients.[58] Welcome to the world of IoT cyber security risk.

While the IoT provides significant opportunities to improve people's lives and businesses, the implementation of these solutions clearly introduces new challenges. The substantial growth of IoT for consumers and industries compounds the already significant difficulties in securing IoT ecosystems. The problem is due to the rapid addition of physical elements and the sheer number of parts in an IoT solution. Securing the IoT requires consideration of not only traditional information technology (IT) hardware and software, but also the additional volumes of operational technologies (OT): sensors, smart devices and connected hardware.

Critically, due to the network effect of IoT solutions, a successful cyber attack has the potential to affect not only one asset but all assets connected to the system; for example, all hospitals in a region or all power generators in a state. At the same time, each connected asset also becomes a potential 'thing' that can be used to enter or hack the system and therefore needs to be secured as well.

By 2020, it is predicted that more than 25% of identified attacks in enterprises will involve IoT.[59] There are a number of additional complexities for the IoT environment that increase the level of exposure to cyber risks compared to traditional IT environments:

- **High number of edge devices** – the sheer volume of connected IoT edge devices results in a myriad of entry points that are potential targets to gain access to customer information, exploit other connected devices or penetrate back-end systems.
- **Interconnected environment** – since IoT is inherently a connected environment, should someone gain access to the IoT platform, they could control the whole ecosystem of diverse devices connected to it (e.g. all the devices in your home).
- **Low-powered devices** – most IoT devices cannot support complex security schemes due to low-power and computing resource capabilities.
- **High data volumes and data sharing** – protecting IoT systems is complicated by the scale and scope of data being generated and collected, including more detailed and sensitive data types. Beyond the increased cyber security risks, this also raises ethical concerns regarding the level of transparency around what data is being collected and what this data is being used for.
- **Partner collaboration** – IoT systems often involve the sharing of data among many participants, including partners to collect, store or process data.
- **IT/OT convergence** – IoT further blurs the line between OT and IT systems, which have traditionally been relatively segmented and had different approaches to management and security. The seam between IT/OT environments is a potential area of vulnerability, especially for legacy systems that were originally designed to be standalone and unconnected.
- **Physical access** – many IoT devices operate unattended by humans and may be spread over a wide geographic area, increasing the risk of attackers gaining physical access to them. On the flip side, some IoT devices may be in hard-to-reach places (e.g. pacemakers), which can add complexity when security vulnerabilities have been identified and patches or changes need to be applied.
- **Lack of standards** – while IoT is rapidly growing, and can often cross public and private sectors, there is a still a lack of agreed uniform standards to govern its implementation, including around wireless communications protocols or minimum security requirements, e.g. access management, patching.

Some applications of IoT are inherently more secure than others. For example, many IoT systems only involve one-way transmission of data from sensors before that data is aggregated and processed. This type of one-way transmission is more easily protected by traditional mechanisms such as network segregation. While this does not remove the need to address security overall, it can reduce the complexity and therefore the barriers to entry for businesses or governments taking this approach.

## Environment and Health

In March 2016, Verizon described an attack at a water utility: “In at least two instances, [the threat actors] managed to manipulate the system and thus handicap water treatment and production capabilities...based on alerts [we] were able to quickly identify and reverse changes.”[68]

Many applications of the IoT have a direct connection to our environment. Whether it be water utilities, agriculture, manufacturing or waste management, the IoT is enabling functions, such as monitoring and control, that can lead to significant physical impacts. For example in water utilities, IoT technology is used to manage processes including chemical analysis and injection, water pressure and sewage treatment. An attack on security could disrupt water supply, affect water quality and cause sewage leakage, thus directly affecting both the environment and people’s health.

## Safety

The IoT has significant capability to improve safety, from controlling and monitoring pedestrian movement in cities, to sending alerts about unsafe mining worker behaviours, to monitoring the construction of remote electricity towers using drones. However, if things go wrong, the impacts could be catastrophic; for example, losing control of a train or aeroplane, or releasing an automatic valve on a dam.

In 2015, some models of Jeep were shown to be remotely hackable. The research team used mobile connectivity to exploit the multimedia system to connect to the Jeep’s computer systems and take control of steering, braking and most core systems, potentially endangering both driver and bystanders.[69]

## Business Disruption

In 2016, hackers used a ‘botnet’ via smart-home, IP cameras, printers and other connected devices to execute the largest DDoS attack in history on the Dyn Domain Name System provider.[13] This attack shut down the internet in major parts of the US and cost Dyn about 14,500 web domains (representing about 8% of serviced web domains), as customers stopped using Dyn as a provider.[70]

Access to corporate or operational data creates multiple opportunities to disrupt business. For example, hackers have launched attacks that alter transactions between parties, change instructions, or change machine parameters so that products – or even the machines themselves – are damaged. IoT attacks can also involve a distributed denial of service (DDoS) attack, which can prevent access to systems and ‘things’ and cause direct financial loss, or indirect loss due to system downtime. Forty percent of global respondents to PwC’s Global State of Information Security Survey cited the disruption of operational technology as the biggest potential consequence of a cyber attack.[62]

## Information Theft and Tampering

When the use of the IoT includes collecting personal or sensitive corporate data, organisations must carefully consider the risks involved. The ability to tamper with data can create cascading risks as each piece of IoT hardware and point of connectivity is a chance to access data and, potentially, other OT or IT systems. The cost of data breaches is becoming increasingly severe. Under the new General Data Protection Regulations (GDPR), fines for data breaches can reach up to 4% of a company’s global turnover or £17 million, whichever is greater. Reputational damage can also be significant; some estimates put it at up to 750% of the direct costs associated with recovering from attacks.[71]

Earlier this year, personal activity data made public via the fitness tracking application Strava allowed an Australian university student to identify the locations of several military bases in conflict zones around the world, as well as to discern the running routines of the personnel deployed to the bases.[71]

# IoT Cyber Security Risks for Leading Industries

ASSESSMENT OF THE SEVERITY OF THE RISK TYPE BY FOCUS INDUSTRY

| | Healthcare and social services | Manufacturing | Construction | Mining | Agriculture, forestry and fishing |
|---|---|---|---|---|---|
| Environment and health | Very high | High | High | High | High |
| Safety | Medium | High | High | High | Medium |
| Business and service disruption | Very high | High | Medium | Medium | Low |
| Information theft and tampering | Very high | Medium | Medium | Medium | Low |

## Healthcare and Social Services

The potential benefits to consumers and practitioners in healthcare and social services are significant, from remote monitoring to asset tracking, to delivery of medicine and pain relief. The IoT security challenges in health can include backup systems in the case of machine maintenance or failure, data deluge affecting physicians and staff, and risks to highly regulated data privacy requirements. The risks in the case of a security breach extend to disruption and, potentially, safety. With 25% of Australian healthcare technology investments in medical devices and 37.5% in mobile devices,[60] the relevance of IoT security is clear. The focus on IoT risks is rising in Australia with 25% of healthcare organisations saying securing medical devices is one of their top-five security challenges.[60] Australian healthcare providers are spending an estimated A$53 million per trillion of GDP on external cyber security services as of April 2017.[61]

## Manufacturing

With automation a key driver, manufacturing has been a major beneficiary of the capabilities enabled by the IoT and the sector will continue to rely heavily on it into the future. However, the risks are significant: 40% of Australian companies that use automation and/or robotics say the most critical impact of a successful cyber attack would be a disruption to operations and manufacturing.[62] The potential for disruption doesn't sit only in the factory, it also extends to enterprise systems. For example, if a customer relationship system was interconnected with a manufacturing system, a breach creates the risk of privacy invasion and data theft or tampering in one or both systems. Another risk with manufacturing is that any breach that affects operational technologies can also affect the environment; for example, a spill of chemicals used in processing, or health and safety risks due to automation equipment movement causing physical hazards. The Australian manufacturing industry spends an estimated A$96 million per trillion of GDP on external cyber security services as of April 2017.[61]

## Construction

As the Australian construction industry increases its use of the IoT for supply chain management, worksite safety, and beyond, the potential associated impacts will also rise. For example, onsite IoT sensors used to track inventory or vehicles connected to enterprise resource planning systems provide opportunities for threat actors to access, tamper with, or steal corporate data. The IoT also presents risks to health and the environment due to the movement of heavy construction materials, to the safety of workers in warehouses or onsite, and to business due to the disruption of high-value assets, supply chains or work planning, or fraudulent misappropriation of funds. The sharing of documents between contractors, onshore and offshore suppliers, architects, government agencies and beyond, also creates opportunities for threat actors to access the IoT elements and disrupt or corrupt business. The Australian construction industry spends an estimated A$5 million per trillion of GDP on external cyber security services as of April 2017.[61]

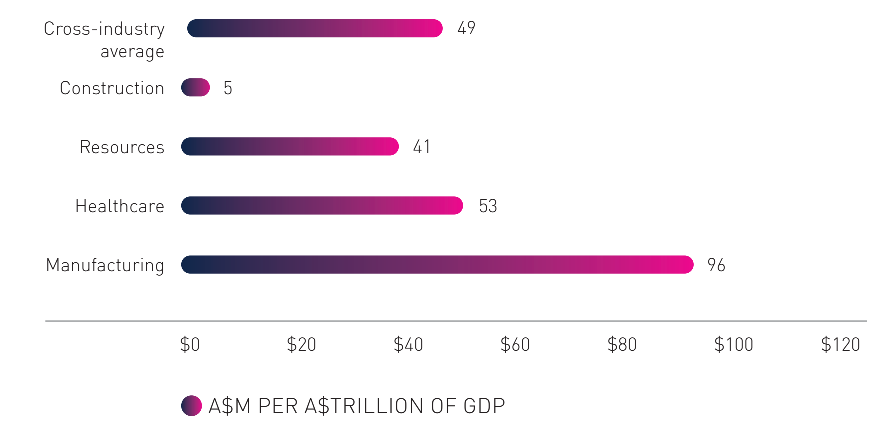
## Mining

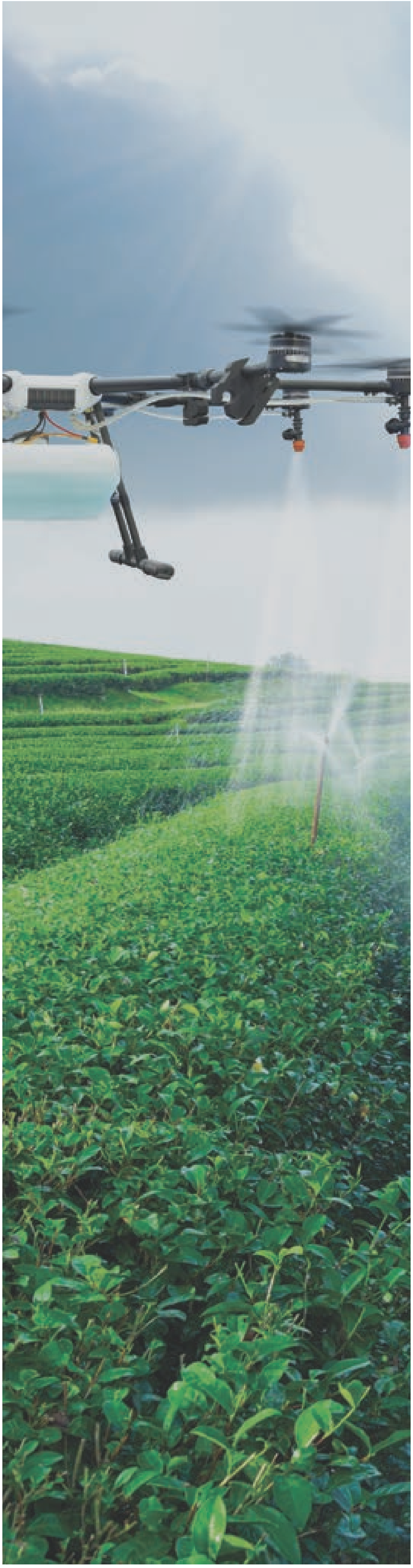
The mining industry is critical to Australia, and IoT technology innovation will be a key driver of its continued success. Autonomous machines with remote operations centres will dominate the industry by 2030, according to Hitachi.[17] However, significant cyber security risks across the sector will increase in conjunction with the rise of the IoT. These include, for example, IoT-enabled monitoring or control of environmental factors like air quality, and potential health risks due to directing the location of workers' proximity to volatile materials. For activities that involve digging or transport, safety can be put at risk if a remotely controlled vehicle malfunctions or a sensor misrepresents the balance or direction of machinery. Business disruption can span from the altering of workers' locations and schedules to the misrepresentation of available materials (commodity inventory), specialty mining equipment, and beyond. A cyber attack on OT, and its subsequent alteration or shutdown, could lead to injuries and fatalities of mine personnel and contractors. The Australian resources industry including mining spends an estimated A$41 million per trillion of GDP on cyber security external services as of April 2017.[61]

## Agriculture, Forestry and Fishing

The benefits of IoT technology in the agriculture sector have been demonstrated, and include the ability to track herds of cattle, maintain appropriate hydration of crops, and monitor the safe transport of products. However, these developments also bring increased risks. For example, the fact that IoT technology can significantly reduce the need for human intervention, particularly in remote areas, means that farm businesses may come to rely more heavily on the information collected and acted upon from IoT sensors. The ability of the IoT to affect the environment, disrupt business, affect the health and safety of animals, and alter decision-making information, therefore, is significant.

CURRENT AUSTRALIAN ESTIMATED SPEND ON CYBER SECURITY BY INDUSTRY[61]



## Controls and Mitigations

To control and mitigate the impact of risks created by the use of IoT technologies, organisations must set a strategy and take action through active and ongoing processes, procedures, automation and protection. IoT implementations should be created with a concept of 'secure by design', wherein organisations build security controls and techniques into the lifecycle of the technology and the culture of the affected organisations.

Many organisations globally are starting to take action on both the IoT security and privacy fronts. In 2017, 35% of PwC's Global State of Information Security (GSISS) respondents said they have an IoT security strategy in place, and a further 28% are implementing one. Also, 46% of respondents said they plan to invest in security for the IoT over the next 12 months. They plan to fund initiatives such as new data-governance policies, device and system interconnectivity and vulnerability, employee training, and uniform cyber security standards and policies.[63]

A strategy supported by controls (both manual and automated) is necessary to enable effective response and mitigation when required and to create a culture of security and resilience. The strategy requires regular revision and updating to keep up with the ever-changing technology landscape. The strategy should be based on at least the following core principles:

- **Holistic system-wide risk approach** – since IoT is an interconnected ecosystem, the approach to IoT security and risk should consider the entire system holistically. This includes spanning both IT and OT domains. It also includes considering the non-technology aspects of the system – e.g. physical security measures to avoid unauthorised physical access to devices; a strong focus on the human-related factors of cyber security.
- **Balance innovation and risk** – while the wealth of data from IoT opens the door for new insights and innovation, organisations need to find the right balance between making data available for innovation and tightening controls to reduce risk.
- **Data governance** – organisations need to understand the types of data that are being collected by the IoT system, such as level of sensitivity, in order to apply an appropriate risk-based approach to data protection.
- **Favour a loosely coupled architecture** – loose coupling of systems will help protect the overall system from a compromise of individual system components.
- **Identity and access management** – ensure provisioning and authentication controls are implemented and managed consistently across the organisation. While processes for provisioning and authentication may differ within IT and OT depending on the criticality of the system, centralised identity and access management provides oversight on access and privileged use for all staff and devices. Similarly, a current inventory of authorised and unauthorised devices is required to enable identification of potentially malicious devices.
- **Password management** – as with traditional IT systems, passwords are often the weakest link with IoT systems. Appropriate password management processes and controls should be in place, including ensuring default manufacturer passwords can be and are changed, and that passwords are of sufficient strength and changed regularly.
- **Security testing** – ensure there is a formal plan, schedule and necessary resources for automated and/or manual testing of IT and OT systems and devices on a periodic or on-going basis.
- **Security monitoring** – adequate processes and procedures should be in place to constantly monitor for cyber security vulnerabilities and incidents. Monitoring should extend from the server through to the sensor and can employ both manual and automated tools to identify anomalies (e.g. data traffic anomalies) and to respond both proactively and reactively.
- **Network segregation** – apply barriers of network access, supported by controls such as firewalls, to protect more sensitive areas of the IoT system from unauthorised access.
- **Configuration and patch management** – the components of an IoT system should be able to be changed after they are initially deployed. Adequate processes should be in place to manage configuration and patch requirements across IT and OT elements, from the server down through sensor firmware, and across all of the connections in between. This is especially important for physical devices that are in hard-to-reach places (e.g. pacemakers).

## Australia's Performance in Cyber Security

Stakeholders in Australia are aware that cyber security is critical for the country's prosperity. As a nation, Australia has been investing in supporting and improving its cyber security capabilities. Government and professional bodies together are actively supporting this, with the federal government releasing Australia's Cyber Security Strategy in 2017 and showing consistent progress to improve partnerships, active defences, global responsibility and influence, as well as growth and innovation.[64] Australia has the status of 'leading nation', according to the United Nations International Telecommunication Union (ITU), with the equal sixth-highest Global Cybersecurity Index (GCI) score.[57]

Australian organisations are planning multiple efforts to improve IoT cyber security. According to the Global State of Information Security Survey (GSISS), within the next 12 months 44% of companies plan to put in place uniform cyber security standards and policies for IoT devices, 20% are implementing employee training on IoT security, and 28% will be assessing device or system interconnectivity and vulnerability.[63]

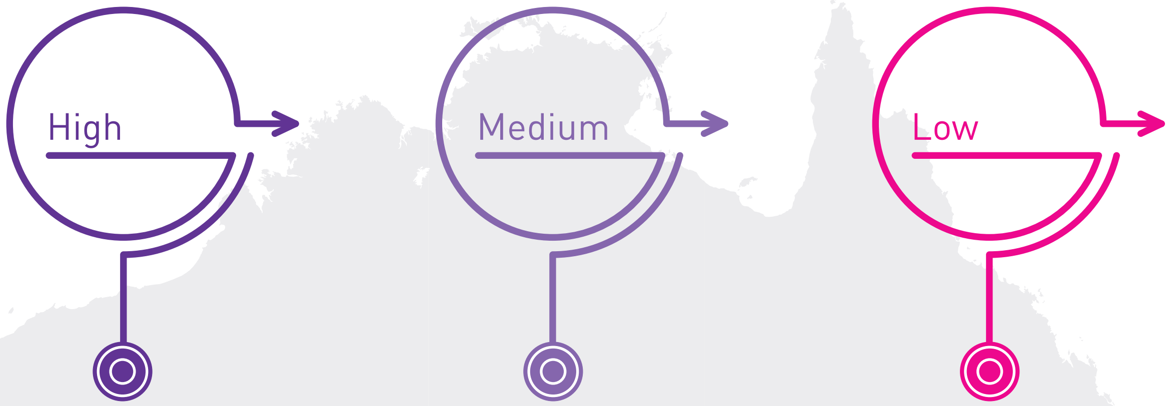
In 2018, the Australian Government passed the *Security of Critical Infrastructure Act* to enforce the protection of security around infrastructure that is frequently connected across key industries, including resources and communications.[65] A number of federal government organisations are now in place to support and enable security and resilience, including CERT Australia's Joint Cyber Security Centre (JCSC), Australian Cyber Security Growth Network (AustCyber), and the Australian Cyber Security Centre (ACSC/CSOC). Multiple public-private partnerships have been established, including between CBA and UNSW, Data61 with RMIT, and others.

Australia scores high in terms of strategy and standards for cyber security but has still room for improvement regarding cooperation. The strongest scores were in the domains of legal, technical, organisational and capacity building, where the country ranked third in the Asia Pacific region. The highest score was for the technical domain, coinciding with the country's proportionately high spending on technology.[57]

AUSTRALIA'S RANKING IN THE GLOBAL CYBER SPACE[57]


SOURCE: GCI

## Australia's Score in the 2017 GCI Assessment




**High**

- Cyber criminal legislation
- Cyber security legislation
- Cyber security training
- **LEGAL MEASURES**
- National CERT/CIRT/CSIRT
- Government CERT/CIRT/CSIRT
- Sectoral CERT/CIRT/CSIRT
- Standards for organisations
- Standards for professionals
- Child online protection
- **TECHNICAL MEASURES**
- Strategy
- Responsible agency
- Cyber security metrics
- **ORGANISATIONAL MEASURES**
- Standardisation bodies

**Medium**

- Incentive mechanisms
- **COOPERATION**

**Low**

- Bilateral agreements
- Multilateral agreements
- Public-private partnerships

SOURCE: GCI

## Using Cybersecurity to Advance Australia's IoT Agenda

Australia has an opportunity to use cyber security to advance the nation's IoT agenda. This approach involves taking advantage of the current positive momentum around cyber security to identify areas that will enable further growth across the public and private sectors, and improve national security. There are opportunities to create jobs, revenue and a more secure environment through collaboration, education, and the creation of services to address the new risks introduced by the IoT.

## Collaboration

The ability of public and private organisations, as well as nations, to collaborate to improve cyber security is essential to surviving and thriving in the era of IoT technologies. Collaboration is key to tackling cybercrime in Australia[3] because the growth of the country's economy depends on business and consumers having trust in the nation's infrastructure and digital systems. It has been demonstrated that collaboration delivers substantive cyber security benefits: 20% detection of more security incidents, 27% receipt of more timely threat alerts, and 13% improved regulatory compliance.[66] In 2018, 63% of Australian companies reported collaborating within the industry to mitigate risk, a 6% reduction compared to 2017.[60]

As adversaries work together against Australia's national interest, the only effective response is cooperative action – bringing together private and public sectors to battle the threats posed to the country's digital infrastructure. However, Australia has very few public and private sector partnerships.[57] As previously noted, organisations such as the JCSC have been created to bring together academia, businesses and government to increase sharing. But support for JCSC and AustCyber must be increased to enable the national community to benefit from pooled intelligence and cyber security capabilities.

Australia's bilateral and multi-lateral agreements in relation to cyber security are either poor or non-existent.[57] Framed properly, these information-sharing agreements could leverage the intelligence being collected abroad, as well as provide an opportunity for Australia to become a key contributor in the global cyber security community – specifically in IoT technology where Australia's leading industries, distances between urban centres, and variety of landscapes enable innovation and testing of new security techniques and capabilities.

## Education of People and Education for People

Australia will need to significantly increase the country's skills and expertise in cyber security to support the growth of both traditional IT and the additional OT that enables the IoT. The Australian Cyber Security Growth Network (ACSGN) has estimated that in the next 10 years another 11,000 skilled workers will be needed to support the 19,000 that are currently working in the industry,[61] in addition to current capabilities and programs. TAFE institutions will offer new qualifications in cyber security to aid the development of this workforce. The impact of this newly skilled potential workforce, combined with the organisations to support them, is estimated at an additional A$1.3 bn p.a. in revenues across cyber software, protection services, and services for underlying support.[61] In addition, exporting cyber security education is a significant opportunity for cyber providers and would build on Australia's existing reputation in international education.

## Operational Technology Empowered Services and Tools

To support the growth of the IoT across Australia's leading industries, new capabilities in the protection of operational technology are required. These capabilities include both new services and the development of technologies that can remotely and automatically secure assets. Most of these skills are needed onshore and span multiple domains, including cyber security, forensics, computer science, data science and analytics. Leveraging technology by using advances in automation and analytics could drive revenue in the case of the skills shortage, as those technologies will increase the need and availability of cyber security experts, by replacing technical jobs in other areas. Cyber security technologies have the potential to deliver A$1,233 million per trillion of GDP in software and services.[61] With IoT predicted to represent 27.8% of the cyber security market in 2020,[67] the potential for IoT cyber security revenue is A$342 million per trillion of GDP.[67]

To enable this growth, investment in both human resources and R&D is required. Australian cyber security firms such as Cog, Nuix, Penten, Huntsman Security, Stratokey, Mailguard, ResponSight and others have proven that Australia can compete in the global cyber security market. Specifically, Cog has focused on creating software to enable IoT-connected hardware and similar devices to deliver government-grade security. Supported by incubators like Stone & Chalk, as well as multiple grants and government funds, these organisations are creating Australia's cyber security industries of the future.

With the IoT predicted to represent 27.8% of the cyber security market in 2020, the potential for IoT cyber security revenue is A$342 million per trillion of GDP.

# Recommendations

06

The impact of the IoT is broad: Australian governments, businesses, institutions and consumers are all affected by this technology. As a result, many stakeholders have a role to play in making sure that Australia makes the most of the IoT opportunity and manages the risks involved. To help guide high-level decision-making, we have identified a set of key recommendations for leaders in both the public and private sectors.

# Private Sector: Boards and C-Suite

The private sector is well positioned to spearhead the adoption of the IoT in Australia. As private companies will directly benefit from their investments through significant productivity gains and increased competitiveness, they will need to play the most important part in further research, development and deployment of the technology.

However, many private sector incumbents are currently in a state of confusion. Most are still trying to understand the new world of digital disruption that is now knocking on almost every industry's door. The boardrooms and C-suites of Australia appear not yet fully convinced, neither about the burning need for change nor the true benefits that new technologies and ways of working can deliver. Solution providers are partly to blame, by focusing on the technology itself, rather than cutting through the hype and being crystal clear on the specific pain points and business outcomes that the solutions can address.

As a result, it's often the case that responsibilities to drive innovation are still ill-defined, or left with the wrong part of the organisation; the organisation is unable to work with dynamic startups and other potential partners in the ecosystem; and the link between technology and business is unclear. Additionally, many businesses that are starting to innovate with proof of concepts around new technologies are struggling to industrialise these into broader enterprise solutions. In short, a lot of time can pass before an established private sector company starts to build the momentum required to leverage the IoT's full potential.

To address these challenges, we see four priorities for Australian businesses in industries with significant IoT impact:

## Adopt an Investor's Mindset: The Returns Will Come in Time

- Technological change is happening at an ever-increasing speed, creating immense pressures on most commercial organisations to lead with innovation or at a minimum, adapt 'fast enough'. The IoT is no exception, and requires the appropriate frameworks and a systematic approach that **optimises the resources invested and at the same time prevents analysis paralysis.**
- Initial success will come much faster if the effort can be **focused on a few specific opportunities** that address a clearly defined business problem, rather than trying to solve often ill-defined larger challenges or drive innovation for innovation's sake.
- However, as with most new and often untested innovations, it will typically be unclear how exactly the results will pan out, or indeed whether an initiative will ever be successful. Therefore, companies need to take an **investor's portfolio mindset** and select a number of opportunities to explore, with enough funding to have a realistic impact, but without expecting a ROI from all of them.
- A **variety of vehicles** to do so are available, particularly to larger incumbents. The organisation can establish a *venture capital-style fund* where opportunities get incubated independently until they are ready to move into the broader organisation. Another vehicle is a new organisation in its own right; for example, a large construction company is currently considering to establish a 'NewCo' that is run almost entirely on new technology and can do so in much more agile ways as it has no legacy workforce, systems or agendas. Yet another vehicle is a *'growth unit'* within the current organisational setup; lastly, an organisation could simply *leverage the existing R&D department* but ensure very specific mandates to achieve outcomes through the IoT.

## Assemble a Business-led, Multidisciplinary Team with a Clear Mandate

- Any innovation applied in a commercial organisation needs to drive the organisation's purpose, strategy and, ultimately, commercial outcomes. While IoT solutions are innovations of a technical nature, they exist to solve business problems, and their design and implementation, therefore, need to be **business-led**. It takes an entrepreneurial mindset with strategic vision, commercial acumen and some understanding of technology to identify the appropriate IoT use cases that can provide strategic benefits and separate them from those that possibly appear technologically advanced but may have limited business impact.

- The team to detail and implement the solutions needs to be **multidisciplinary**. Engineering and IT capabilities are required for bespoke technical solutions; commercial understanding for a realistic business model and business case; operational expertise to understand the current and future processes; and organisational and change management capability to redesign them in a workable manner while bringing the organisation along.
- The more a team member is able to **work together with other team members in agile ways**, has a basic but not necessarily very deep understanding of technology, and understands how the broader organisation may react to the new solution, the more successful the IoT implementation will be. The agile way of working needs to extend beyond the organisation's boundaries into the partnerships and supplier/customer relationships that are likely to be required to establish the broader ecosystem for each new solution.

## Establish a Data Strategy: An Immediate 'No-regrets' Move

- Data is the underlying currency of the IoT. To make meaningful semi-autonomous or potentially fully autonomous decisions, an IoT system needs to collect and interpret vast amounts of it, and most solutions become more powerful as more data becomes available. This can quickly extend beyond the immediate technical data that the system can generate itself. Linking technical data with commercial data, for example, can vastly improve and automate critical operational decisions and link markets with operations. Every organisation should draft a **holistic data strategy**.
- However, many organisations even today struggle with capturing, storing, cleansing and analysing their data. The datasets required for the applications of the future are much vaster and ever more complex. While limitations on data handling in many incumbents already drives sub-optimal decision-making, in a future world where data drives everything this is an untenable position. Every organisation should have a strategy to **capture, store and secure relevant business data**.
- An assessment of the currently generated data versus the theoretically available data needs to be undertaken in parallel. Doing so makes it possible to **identify further use cases** that exploit the organisation's specific data that is or could be made available, and to define the steps that need to be taken to **establish a strong data capability** from a systems and organisational perspective. For example, a leading telco player recently cooperated with a leading logistics player to equip several thousand trucks with sensors for the collection of a variety of data that will ultimately allow both companies to commercialise new business models and achieve operational efficiencies.
- As the adoption of IoT devices rapidly increases, an increasing volume of data is being passively collected, not only on 'things' but also the users of 'things' – the individual customer or citizen. This often happens without the individuals' awareness of what data is being collected, how it is being used, who it is being shared with and how it is being protected. This raises significant issues around the ethical use of data. The challenge for private sector companies is to ensure they **maintain consumer and public trust** by providing greater transparency and choice, and by actively considering whether potential data uses are in line with the broader public's expectations, as well as with any relevant regulatory requirements.

## Design an IoT Innovation Framework: 'Fail Fast', but Not Randomly

- A **strong corporate strategy** that guides investments of money and resources into the broader IoT opportunity is required to ensure the aforementioned alignment with business outcomes and objectives. If this direction is absent, organisations can quickly lose large amounts of time and money chasing relatively random ideas that may appear technically advanced but have limited business impact. On the flipside, traditional strategy design methodologies are of only limited use in a fast-moving digital world, as they are typically designed for a less dynamic environment. Hence, the corporate strategy is required, but in turn needs to **guide a highly flexible and agile IoT strategy** that can quickly adjust to new circumstances, new 'foes, friends and frenemies', new technological developments and new opportunities. In short, an organisation needs to strike the **right balance between traditional strategy and an overly casual approach** to guide its efforts and investments in the IoT space.
- To achieve this, traditional innovation management approaches are more applicable and important than ever. Organisations should design and implement a clear IoT innovation process that runs through a number of stages to create the biggest impact for the business with the resources available:

1. Ad hoc or ongoing creative **idea generation** to establish an opportunity pipeline. The organisation needs to decide where it would want to position itself on the spectrum of, on the one side, involving the entire organisation in an agile continuous innovation process, or on the other side, a small team with a focused mandate to do so.

2. Drafting high-level **business cases** for each opportunity that captures the desired outcomes and how they align with corporate strategy, describes the required capabilities and funding, and outlines a roadmap to achieve the outcomes.
3. **Prioritisation** of the opportunity pipeline, considering alignment with corporate strategy, business impact potential, and innovation synergy potential on the one hand; and required funding, organisational challenges and general implementability on the other.
4. **Proof of concept** design and execution, where the highest priority ideas are supported with sufficient funding and resources, without the addition of further bureaucracy that could stifle the required 'fail fast' approach. In particular, incumbents that are typically not used to very fast decision-making may need to carefully consider how they can shield this step from organisational interference once the prioritisation decision has been made.
5. After a successful proof of concept, **incubation and scaling** need to follow. Again, it is important to ensure a period of development that is unrestricted from typical organisational performance pressures and agendas. Training and other capability building measures are often required to ensure a successful rollout.
6. **Integration** into day-to-day business. This is not always easy, as the broader organisation will have to accept new structures and ways of working, which can require a significant change management effort. Senior executive sponsorship and appropriate formal and informal change management processes are often required to ensure the full exploitation of the opportunity.

### Support the Broader Australian IoT Development

- To allow Australia to establish a competitive IoT environment to the benefit of all Australian stakeholders, Australia's private sector organisations should support industry- and technology-wide **standardisation activities**.
- Within the broader community of IoT stakeholders, commercial organisations should also **collaborate in trying, testing and learning** activities to overcome basic IoT entry-level challenges and focus on developing higher value services, and thereby accelerate Australia's overall IoT services maturity.

## Government: Elected Leaders and Policymakers

As much as the IoT should be driven in the first instance by the private sector, in areas where government is the key buyer, such as in construction or healthcare, it needs to get into the driver's seat. As long as suppliers make healthy margins without pressure from their major customers to deliver more innovative solutions or deliver products and services in more efficient and effective ways, there is limited incentive to undergo either significant R&D or the required change programs.

Leaving the drive for innovation in the hands of startups, while larger incumbents may be lacking the incentive to change, is likely to result in a long wait before the benefits of the IoT come through at scale.

Furthermore, government has a role to play in the general enablement of the IoT. Other studies, in particular *Enabling the Internet of Things for Australia* by the Communications Alliance (2015), have already made a series of recommendations on regulations and networks; hence, this report focuses on the economic and commercial questions.

We see four priorities for government to help accelerate the adoption of the IoT in Australia:

### Create a Strong IoT Strategy through multi-disciplinary engagement

- To ensure Australia's limited resources, but also its key comparative advantages as a nation, are leveraged in the most optimal way, the country requires a broader **national IoT strategy** that clearly articulates plans to achieve adoption of the IoT as quickly and as broadly as possible. This strategy can then be used to align all relevant stakeholders and help identify gaps and ways to address those gaps. It would also allow for the alignment of industry incumbents as well as IoT solutions providers. Such an IoT strategy should address several key areas:
  - Establish the strategy with the **representation of the relevant stakeholder groups:** government, associations, universities, startups, IoT service providers, consulting service providers and, critically, target industry incumbents. The group that establishes the national strategy needs to be **multi-disciplinary** and balance business, social, economic and ICT representation.
  - **Focus on those IoT ecosystem elements and industries in which a 'right to win' is paramount.** We have identified these areas both from an IoT industry perspective as well as from an economic perspective in Chapters 3 (construction, healthcare, mining, agriculture, manufacturing) and 4 (applications, cyber security, solutions services, niche hardware). Success in these areas will be a strong starting point for wider adoption.

- To accelerate a country's capability in new technology, **developng clusters** to create scale is critical. Geographically concentrated clusters of stakeholders – startups, multinationals, associations, incumbents – can provide those stakeholders with the opportunity to nourish each other, create critical partnerships and exchange ideas. It also attracts much needed global and local talent.
- In sectors where structural challenges may prevent broader adoption, such as healthcare or agriculture, **specific incentive structures** should form a key part of the strategy. A good example of a successful incentive program is the ACT Government's Next Generation Renewables Program and Renewable Energy Innovation Fund, which has been successful in driving momentum in the renewables space.
- The strategy should encourage **incumbents to become both users and developers** of IoT solutions to ensure long-term competitiveness, create fit-for-purpose solutions, provide the opportunity to export IoT solutions developed in Australia, and establish a degree of independence in future core technology from international markets and service providers. Standard, open systems, open APIs and dedicated spectrum that is compatible with international standards may be a part of this. Governments should also consider opening their relevant data for commercial exploitation.

## Create Government Demand

- In B2C- or B2B-driven markets, customer needs typically generate a strong incentive for suppliers to innovate. However, where government is the key client, there is often **less of a pull for innovation**, resulting in slower adoption of new technologies. This is the case, for example, in construction and health.
- For those industries, government needs to generate a **holistic and detailed framework and strategy for IoT adoption**. Most likely this will need to be a multi-level approach from federal, state and local governments so that the requirements are clear and coordinated. It should include, for example, a data and IoT strategy for each new government asset to be built, be it a new rail project or the major upgrade of a hospital. For relevant assets of critical importance for IoT development, those plans should be mandated.
- To effectively drive this demand, government cannot merely rely on private sector opinion and advice. Rather, it should **build its own IoT capability** at a strategic and project management level, as it otherwise risks being influenced by at times conflicting views and different agendas. In select areas, such as healthcare or infrastructure construction, government demand should go as far as mandating an IoT deployment plan for the majority of projects, which would need to articulate how a tender participant is going to resource service delivery and demonstrate improvement of effectiveness.

## Address Structural Industry Challenges to IoT Adoption

- Where industry structures may otherwise prevent its application or take too much time to implement, government may need to **mandate the use of specific elements of the technology**. For example in healthcare through certain data sharing protocols in primary care, or in construction through the deep application of BIM for new infrastructure projects.
- In situations where they may create a roadblock to a more efficient IoT environment, government may need to **adjust the incentive structures** of relevant stakeholders to transform entrenched ways of working. Contract structures in infrastructure or revenue generation and remuneration models in health are key areas to be addressed.
- In fragmented industries where individual players may be too small to drive or commercialise innovation (for example, in agriculture or some manufacturing sectors), government may need to provide additional specific support:
  - It should **provide early stage funding** for key solutions – generally software, but also hardware in promising niche segments – that may provide international competitive advantages. In later stages of the innovation process, **tax breaks** may also be a meaningful vehicle.
  - It should create **forums for the industry**, or support existing forums such as industry associations, with the objective to provide information and skill transfer, create industry access for startups and IoT solution providers, facilitate collaboration, and provide and manage government incentives for R&D or technology adoption.

## Ensure IoT Enablement

While government needs to play a direct and active role in setting the IoT strategy for the nation, in driving IoT demand where it is a significant customer, and in overcoming specific structural challenges in selected industries, it also needs to play an enabling role across a number of complex dimensions for the IoT:

- **R&D funding and collaboration with tertiary and research institutions**. According to the OECD, Australia is falling significantly behind in R&D when measured as a percentage of GDP. This effect is driven by both government and industry and comes at a time where many other advanced economies are in fact increasing, rather than decreasing, their R&D efforts and spend. Australian universities and other research institutions that partner with industry are particularly disadvantaged as they rely on public sponsorship. For the development of a new, broad and complex technology like the IoT, this lack of general funding is clearly sub-optimal, and should be encouraged and increased directly and indirectly.
- **Stakeholder collaboration:** Collaboration between the various stakeholders in the IoT environment from startups to research institutions and incumbents to government is critical for successful innovation in the Australian IoT space. Government should support this collaboration, for example through:
  - Creation of a regulatory sandbox that could allow the stakeholders to experiment with novel IoT services
  - Tax breaks for open sharing through Try, Test & Learn models
  - Creation of collaboration spaces and clusters
  - Encouragement of data sharing – whether that data is generated by government, publicly, or through businesses.
- **Data networks:** While building out the required networks for the IoT is primarily the task of the private sector, government needs to ensure fair competition, encouraging technically and commercially optimal network types that can thrive regardless of the scale of the incumbent players. Specific government support in the form of subsidies or communication infrastructure investment may be required for specific applications in remote locations for industries such as agriculture in order to avoid putting undue burden for enablement costs on the private sector.
- **Talent:** The competition for talent in the ICT space, and more so the IoT space, is global, and Australia cannot afford to reduce the influx of much-needed talent to accelerate the adoption of the IoT while the nation strives to build – and retain – its home-grown talent. The Australian Government's new visa trials of the Global Talent Scheme are a significant step to attract foreign talent. Other potential initiatives include proactive measures to attract top talent from overseas universities or organisations; to retain top overseas student graduates at Australian universities; or to provide tax incentives to encourage overseas multinationals to set up R&D labs locally.
- **Regulation:** Government needs to ensure that old world regulation does not unnecessarily stand in the way of new world IoT solutions, and review where key discrepancies will become critical. This is potentially the case, for example, in the regulation of software in medical devices that may currently have to run through a complex approvals process for every required patch, or in local government procurement rules that make it hard to create ecosystems of partnerships that are required for innovative IoT solutions.
- **Cyber security:** Government and private sector need to embrace cyber security as an enabler, and not ignore risks until it is too late. Taking a long-term view on building the required skills, including longer term education, government policy, and government and private sector interaction is critical so that risks can be addressed. Ultimately this will need to lead to a risk-based mindset rather than compliance-based mindset.
- **Data sharing and privacy:** Data is the lifeblood of the digital economy, and its collection and use is an essential component to drive innovation with the IoT. Government has a key role to play in addressing the challenge around balancing this use in a safe and ethical manner. Government must work to support the development and deployment of privacy-preserving data-sharing frameworks suitable for IoT services, while also working with industry groups to develop regulations and set minimum standards around how personally identifiable data is managed (for example, around transparency and consent, as well as storage and transmission).

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# Glossary

| TERM | DESCRIPTION |
|---|---|
| ACSGN | Australian Cyber Security Growth Network – see AustCyber. |
| AI | Artificial intelligence – describes when a machine mimics cognitive functions that humans associate with other human minds, such as 'learning' and 'problem solving'. |
| AUSTCYBER | AustCyber (the Australian Cyber Security Growth Network) is a not-for-profit, industry-led organisation that supports the development of a vibrant and globally competitive Australian cyber security industry that enhances Australia's future economic growth and helps protect Australia's interests online. |
| CAGR | Cumulative Annual Growth Rate – refers to the mean annual growth rate over a certain period of time, usually longer than one year, based on the assumption that the investment grows in terms of value on a steady rate, compounded annually. |
| CLOUD/CLOUD COMPUTING | The delivery of computing services – servers, storage, databases, networking, software, analytics and more – over the internet ('the cloud'). |
| GDP | Gross Domestic Product – the monetary value of all the finished goods and services produced within a country's borders in a specific time period (typically a year). |
| ICT | Information and communications technology – see IT. |
| INCUMBENT | In this report, used to describe larger or established players in an industry. |
| IoT | Internet of Things – the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators and connectivity that enables these things to connect and exchange data, creating opportunities for more direct integration of the physical world into computer-based systems, resulting in efficiency improvements, economic benefits and reduced human exertions. |
| IT | Information technology – the use of any computers, storage, networking and other physical devices, infrastructure and processes to create, process, store, secure and exchange all forms of electronic data. |
| JCSC | Joint Cyber Security Centre program – a partnership between business, government, academia and other key partners to enhance collaboration on cyber security. |
| LoRa | Stands for long range. It is a digital wireless data communication technology that uses licence-free sub-gigahertz radio frequency bands and enables very-long-range transmissions (more than 10 km in rural areas) with low power consumption. |
| LPWAN | Low-power wide-area network – type of wireless telecommunication wide-area network designed to allow long-range communications at a low bit rate among things (connected objects), such as sensors operated on a battery. An LPWAN may be used to create a private wireless sensor network, but may also be a service or infrastructure offered by a third party, allowing the owners of sensors to deploy them in the field without investing in gateway technology. |
| MACHINE LEARNING | Machine learning is a subset of artificial intelligence in the field of computer science that often uses statistical techniques to give computers the ability to 'learn' (i.e., progressively improve performance on a specific task) with data, without being explicitly programmed. |
| MFP | Multifactor productivity is a measure of economic performance that compares the amount of goods and services produced (output) to the amount of combined inputs used to produce those goods and services. |
| NNNCO | NNNCo is Australia's LoRaWAN network operator, delivering IoT networks and end-to-end solutions. |
| OT | Operational technology – the hardware and software that detects or causes a change through the direct monitoring and/or control of physical devices, processes and events in the enterprise. |
| PAAS | Platform as a Service – a category of cloud computing services that provides a platform that allows customers to develop, run and manage applications without the complexity of building and maintaining the infrastructure typically associated with developing and launching an application. |
| R&D | Research and development. |
| RFID | Radio-frequency identification – electronic devices that transmits small packets of data (2,000 bytes or less) using a small chip and an antenna. |
| SAAS | Software as a Service – a software licensing and delivery model in which software is licensed on a subscription basis and is centrally hosted. It is sometimes referred to as on-demand software. |

# List of Interviewees

| FOCUS AREA | ORGANISATION |
|---|---|
| IOT/ICT | AT&T |
| | GE Digital |
| | Hitachi Vantara |
| | Meshed |
| | Morse Micro |
| | Reekoh |
| | Thinxtra |
| AGRICULTURE | Hitachi Consulting |
| | Powertec Telecommunications |
| HEALTH | Ramsay Health Care |
| | 2 Individual GPs |
| MANUFACTURING | FactoryOne |
| | Lion Dairy & Drinks |
| MINING | Wenco |
| CONSTRUCTION | Lendlease |
| | Meshed |
| | Worley Parsons |
| TRANSPORT | Transurban |
| OTHER STARTUPS | Team Uniti |
| | Unleash Live |
| OTHER | BaxterIP |
| | Skeeve Stevens – futurist |
| | Sydney Water |

# Methodolgy

## Australian IoT Ecosystem Market Size and Forecasts

Developed a cumulative multifactor model, in consultation with industry SMEs, to represent the current and future Australian market sizes for each IoT ecosystem segment and for the Australian market overall, factoring in: global research on IoT segment sizes and growth rates; Australian and global ICT market sizes; segment-level Australian market characteristics; and impact analysis of local IoT delivery challenges.

## Top-down IoT Impact Assessment by Industry

For an initial top-down assessment of the IoT impact on the industries, we analysed each step of the generic value chain of each industry for the relevance of IoT implications, resulting in a score of potential IoT impact by industry

Mapping the industries by their GDP contribution and IoT impact score allowed the identification of those industries through which the IoT will have the biggest benefit on the Australian economy

## Maximum Potential Benefits Modelling by Industry

To model the maximum potential benefit by industry as a result of full IoT implementation, we initially undertook secondary global research to collect a broad range of use cases for each of the five focus industries.

A typical benefit range was identified and adjusted through Australia-specific industry interviews with IoT technology players, industry leaders and startups. We also leveraged global PwC/Strategy& practitioner working groups.

Subsequently, each focus industry's Australia-specific composition and cost structure was analysed, which enabled the more tailored application of the identified use case benefit ranges and their extrapolation across the entire industry, resulting in Australia-specific maximum potential benefits.

## IoT Adoption Curve

A standard technology adoption s-curve model was used to estimate benefit realisation over time. Based on our secondary use case and literature research, an average period of 12 years to achieve full potential was assumed. We then adjusted this average depending on specific business challenges that each industry faces, established through industry interviews and PwC/Strategy& practitioner insights. Further consideration was then overlaid in terms of each industry's ability to achieve maximum benefits given natural limitations resulting from specific industry structures and dynamics.

# Key Statistics

## Detailed Industry Scoring Model

| # | INDUSTRY | 2017 GDP CONTRIBUTION ($BN, % OF TOTAL) | IoT ESTIMATED IMPACT ASSESSMENT | | | | |
|---|---|---|---|---|---|---|---|
| | | | EFFICIENCY *(COST REDUCTION OPPORTUNITY)* | | ECONOMIC IMPACT (REVENUE UPLIFTS AND NON-FINANCIAL BENEFITS) | | SCORE (/20) |
| | | | IMPACT SCORE | RATIONALE | IMPACT SCORE | RATIONALE | |
| 1 | Financial and insurance services | 149.0 (9%) | 2 | Limited physical activity; indirect impact only. Insurance risk can be better assessed | 4 | Potential new customers (i.e. use activity data instead of credit history) and improved pricing of risk | 6 |
| 2 | Construction | 125.0 (7%) | 8 | Significant physical activity and coordination requirements | 7 | Innovative spaces, reduced environmental footprint, improved use of resources, increased safety | 15 |
| 3 | Professional, scientific and technical services | 114.9 (7%) | 1 | Limited physical activity | 1 | Limited physical activity | 2 |
| 4 | Mining | 100.3 (6%) | 8 | Significant physical activity and coordination requirements | 8 | Improved yield | 16 |
| 5 | Manufacturing | 99.0 (6%) | 10 | Significant physical activity and coordination requirements | 6 | Improved yield | 16 |
| 6 | Public administration and safety | 93.0 (5%) | 4 | Limited physical activity though improved monitoring | 7 | Proactive security and safety protection of the population | 11 |
| 7 | Education and training | 82.4 (5%) | 1 | Limited physical activity | 1 | Limited physical activity | 2 |
| 8 | Transport, postal and warehousing | 81.5 (5%) | 8 | Significant physical activity and coordination requirements | 5 | Faster delivery, reduced congestion, environmental footprint, security and safety | 13 |
| 9 | Retail trade | 75.8 (4%) | 6 | Automation of the store and the supply chain | 3 | Improved customer experience | 9 |
| 10 | Healthcare | 73.3 (4%) | 8 | Significant physical activity and coordination requirements | 8 | Prevention and earlier detection. Patient experience | 16 |
| 11 | Wholesale trade | 70.8 (4%) | 3 | Improved supply chain management | 2 | Faster delivery of goods | 5 |
| 12 | Administrative and support services | 53.5 (3%) | 1 | Limited physical activity | 1 | Limited physical activity | 2 |
| 13 | Rental, hiring and real estate services | 51.8 (3%) | 4 | Real-time management of assets, proactive maintenance | 4 | Improved customer experience | 8 |
| 14 | Agriculture, forestry and fishing | 47.4 (3%) | 9 | Significant physical activity and coordination requirements | 8 | Improved yield | 17 |
| 15 | Social assistance | 46.4(3%) | 7 | Real-time monitoring | 5 | Improved care outcomes | 12 |
| 16 | Information media and telecommunications | 45.1 (3%) | 6 | Various depending on industry participants | 3 | Various depending on industry participants | 9 |
| 17 | Electricity, gas, water and waste services | 41.3 (2%) | 7 | More efficient and effective use of significant asset base | 7 | Reduced prices, environment, improved services, reduced resource reduction | 14 |
| 18 | Accommodation and food services | 40.9 (2%) | 4 | Limited physical activity; indirect impact only | 4 | Improved customer experience | 8 |
| 19 | Other services | 28.4 (2%) | 0 | n/a | 0 | n/a | 0 |
| 20 | Arts and recreation services | 13.9 (1%) | 1 | Limited physical activity | 1 | Limited physical activity | 2 |
| 21 | Other (including ownership of dwellings, taxes, statistical discrepancy) | 260.9 (15%) | 0 | n/a | 0 | n/a | 6 |
| Total | | 1,694.5 | | | | | |

# Employment by Industry

## 000, as of February of each Year

Source: ABS 6291.0.55.003 Labour Force, Australia, Detailed, Quarterly

| INDUSTRY | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|
| Retail trade | 1,189.5 | 1,201.3 | 1,239.2 | 1,229.0 | 1,290.4 | 1,228.2 | 1,315.8 |
| Healthcare and social assistance | 1,328.3 | 1,377.2 | 1,399.6 | 1,474.7 | 1,541.3 | 1,552.1 | 1,707.8 |
| Manufacturing | 949.2 | 921.4 | 928.3 | 905.5 | 883.4 | 892.6 | 901.1 |
| Construction | 995.1 | 1,006.8 | 1,005.4 | 1,019.5 | 1,053.0 | 1,110.4 | 1,198.4 |
| Education and training | 855.1 | 910.7 | 900.4 | 933.2 | 931.4 | 972.8 | 1,037.9 |
| Professional, scientific and technical services | 877.9 | 913.7 | 915.8 | 979.8 | 1,020.2 | 1,008.5 | 1,020.1 |
| Accommodation and food services | 735.9 | 795.0 | 777.7 | 844.5 | 837.1 | 863.5 | 876.4 |
| Public administration and safety | 736.2 | 717.4 | 745.2 | 731.7 | 746.4 | 818.7 | 694.7 |
| Transport, postal and warehousing | 545.5 | 602.0 | 584.2 | 600.7 | 647.5 | 601.3 | 656.5 |
| Other services | 472.7 | 447.6 | 482.8 | 490.4 | 465.9 | 495.8 | 490.3 |
| Financial and insurance services | 420.7 | 412.2 | 410.0 | 405.6 | 422.5 | 444.3 | 427.0 |
| Wholesale trade | 383.8 | 444.6 | 390.4 | 381.3 | 350.3 | 374.3 | 368.0 |
| Agriculture, forestry and fishing | 321.7 | 297.7 | 317.9 | 314.4 | 318.0 | 297.7 | 324.7 |
| Administrative and support services | 393.8 | 387.4 | 393.1 | 384.9 | 425.5 | 417.6 | 406.6 |
| Information media and telecommunications | 218.7 | 213.4 | 194.8 | 215.6 | 210.6 | 209.8 | 217.2 |
| Arts and recreation services | 202.1 | 203.2 | 201.4 | 237.2 | 238.2 | 209.9 | 252.8 |
| Rental, hiring and real estate services | 227.8 | 199.5 | 210.7 | 209.5 | 223.1 | 215.4 | 217.8 |
| Mining | 252.4 | 269.3 | 265.9 | 216.6 | 217.2 | 226.9 | 229.2 |
| Electricity, gas, water and waste services | 154.2 | 135.8 | 147.9 | 139.6 | 138.1 | 131.1 | 151.4 |
| **Employed total** | **11,253.8** | **11,452.2** | **11,505.7** | **11,703.9** | **11,955.6** | **12,067.8** | **12,488.9** |

# Australian Exports by Industry

## $ Millions

Source: DFAT

| INDUSTRY | 2011–12 | 2012–13 | 2013–14 | 2014–15 | 2015–16 | CAGR |
|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | 33,432 | 36,273 | 39,796 | 42,608 | 43,080 | 7% |
| Mining | 131,076 | 144,479 | 165,900 | 142,893 | 126,559 | -1% |
| Manufacturing – Metal products | 10,897 | 10,478 | 11,147 | 11,025 | 10,176 | -2% |
| Manufacturing –Machinery and equipment | 13,163 | 13,042 | 14,191 | 15,580 | 15,945 | 5% |
| Manufacturing – Other manufacturing | 16,680 | 16,034 | 16,770 | 16,902 | 18,506 | 3% |
| Manufacturing – Food, beverage and tobacco products | 10,738 | 10,422 | 9,982 | 10,332 | 9,959 | -2% |
| Manufacturing | 51,478 | 49,976 | 52,090 | 53,839 | 54,586 | 1% |
| Other services | 32,961 | 34,224 | 33,478 | 35,592 | 40,348 | 5% |
| Transport, postal and warehousing | 6,506 | 6,082 | 6,465 | 6,634 | 6,931 | 2% |
| Accommodation and food services | 31,122 | 31,370 | 33,246 | 36,732 | 40,808 | 7% |
| **Total** | **286,575** | **302,404** | **330,975** | **318,298** | **312,312** | **2%** |

# Productivity (Multifactor Productivity) Index by Industry

Note: Calculated using hours worked, no productivity measure for public goods (e.g. health)
Source: ABS

**1994/5 = 100**

| INDUSTRY | 1994–95 | 1995–96 | 1996–97 | 1997–98 | 1998–99 | 1999–2000 | 2000–01 | 2001–02 | 2002–03 |
|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | 100.0 | 107.2 | 110.0 | 109.5 | 114.2 | 116.2 | 118.7 | 119.8 | 110.8 |
| Mining | 100.0 | 103.1 | 101.8 | 101.4 | 99.1 | 101.8 | 105.6 | 104.5 | 101.6 |
| Manufacturing | 100.0 | 100.5 | 100.4 | 101.1 | 102.2 | 101.9 | 102.5 | 103.7 | 103.9 |
| Electricity, gas, water and waste services | 100.0 | 101.8 | 104.6 | 106.3 | 105.7 | 105.8 | 105.6 | 104.2 | 102.5 |
| Construction | 100.0 | 99.8 | 100.7 | 102.6 | 104.0 | 103.4 | 99.3 | 102.3 | 105.9 |
| Wholesale trade | 100.0 | 102.6 | 105.8 | 108.0 | 109.1 | 111.4 | 115.1 | 116.6 | 117.7 |
| Retail trade | 100.0 | 101.1 | 103.2 | 104.2 | 105.0 | 104.7 | 106.5 | 108.3 | 107.7 |
| Accommodation and food services | 100.0 | 99.7 | 100.7 | 102.2 | 104.7 | 104.6 | 104.7 | 105.0 | 106.6 |
| Transport, postal and warehousing | 100.0 | 102.2 | 103.3 | 103.6 | 104.3 | 105.0 | 105.1 | 107.2 | 109.0 |
| Information, media and telecommunications | 100.0 | 99.0 | 98.7 | 102.8 | 104.2 | 100.6 | 98.3 | 99.3 | 99.2 |
| Financial and insurance services | 100.0 | 101.2 | 103.4 | 106.4 | 109.5 | 110.6 | 108.8 | 110.8 | 110.9 |
| Rental, hiring and real estate services | 100.0 | 102.1 | 100.6 | 99.2 | 97.4 | 96.7 | 93.3 | 93.4 | 93.5 |
| Professional, scientific and technical services | 100.0 | 97.0 | 97.1 | 96.7 | 99.9 | 100.1 | 102.1 | 105.8 | 105.5 |
| Administrative and support services | 100.0 | 97.8 | 98.5 | 98.1 | 98.8 | 98.5 | 98.2 | 104.4 | 101.7 |
| Arts and recreation services | 100.0 | 98.6 | 97.9 | 98.1 | 98.5 | 99.3 | 100.3 | 97.7 | 98.4 |
| Other services | 100.0 | 98.9 | 101.3 | 100.9 | 102.6 | 102.7 | 106.6 | 104.6 | 106.0 |

| 2003–04 | 2004–05 | 2005–06 | 2006–07 | 2007–08 | 2008–09 | 2009–10 | 2010–11 | 2011–12 | 2012–13 | 2013–14 | 2014–15 | 2015–16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 122.2 | 124.6 | 126.6 | 117.2 | 120.4 | 127.9 | 127.6 | 129.9 | 130.9 | 131.3 | 131.1 | 132.4 | 128.9 |
| 97.0 | 97.3 | 92.9 | 93.2 | 89.9 | 86.1 | 86.7 | 82.3 | 77.9 | 76.2 | 76.8 | 79.8 | 81.1 |
| 104.7 | 103.4 | 103.3 | 103.5 | 103.6 | 102.8 | 103.4 | 103.3 | 104.1 | 103.4 | 103.7 | 103.5 | 104.0 |
| 101.1 | 99.6 | 97.9 | 96.6 | 93.7 | 92.5 | 91.4 | 89.5 | 88.4 | 88.8 | 86.7 | 87.6 | 87.7 |
| 105.6 | 105.1 | 105.7 | 104.7 | 105.3 | 105.6 | 105.0 | 104.7 | 108.1 | 108.8 | 109.1 | 107.9 | 107.1 |
| 119.2 | 119.7 | 120.6 | 118.4 | 120.6 | 120.1 | 119.9 | 120.3 | 123.5 | 123.8 | 126.3 | 127.7 | 132.6 |
| 110.1 | 109.1 | 108.5 | 110.3 | 111.2 | 111.9 | 114.4 | 114.2 | 116.2 | 117.2 | 118.0 | 118.4 | 119.5 |
| 106.8 | 107.4 | 108.8 | 109.8 | 108.0 | 107.4 | 105.8 | 105.6 | 107.4 | 106.3 | 107.8 | 107.6 | 109.3 |
| 108.4 | 109.2 | 109.6 | 110.8 | 110.3 | 107.6 | 108.6 | 108.8 | 110.5 | 110.8 | 109.9 | 108.7 | 108.5 |
| 100.8 | 99.6 | 99.7 | 100.6 | 102.8 | 103.1 | 104.6 | 105.3 | 104.2 | 103.1 | 106.4 | 108.0 | 110.9 |
| 112.4 | 112.4 | 112.4 | 115.9 | 117.7 | 117.3 | 117.2 | 118.2 | 120.0 | 122.7 | 123.7 | 126.4 | 127.3 |
| 89.1 | 87.1 | 86.0 | 81.6 | 78.9 | 80.5 | 80.3 | 77.8 | 79.1 | 82.0 | 84.6 | 85.0 | 88.4 |
| 106.6 | 104.8 | 103.0 | 102.5 | 101.4 | 103.8 | 104.2 | 106.9 | 107.4 | 107.7 | 107.7 | 105.6 | 105.8 |
| 101.6 | 102.1 | 106.2 | 110.3 | 115.2 | 111.1 | 105.1 | 106.4 | 105.0 | 105.3 | 109.9 | 110.3 | 108.4 |
| 100.7 | 100.6 | 98.1 | 99.7 | 97.3 | 98.5 | 99.5 | 98.8 | 99.1 | 98.0 | 100.6 | 98.3 | 97.5 |
| 106.3 | 105.0 | 104.4 | 104.3 | 100.6 | 102.3 | 103.1 | 101.9 | 104.0 | 102.0 | 100.2 | 101.2 | 101.2 |

## Productivity of OECD Countries

Source: OECD

| | | GDP/Hours Worked (USD) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| COUNTRY | 2016 GDP ($USD M) | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| United States | 18,624,475 | 61.9 | 62.1 | 62.2 | 62.3 | 62.7 | 63.1 | 63.3 |
| Japan | 5,369,479 | 39.5 | 39.6 | 40.0 | 40.8 | 40.8 | 41.4 | 41.6 |
| Germany | 4,030,399 | 56.3 | 57.5 | 57.8 | 58.3 | 58.7 | 59.2 | 59.9 |
| United Kingdom | 2,798,060 | 47.3 | 47.4 | 47.1 | 47.3 | 47.4 | 48.2 | 47.9 |
| France | 2,765,543 | 57.0 | 57.5 | 57.6 | 58.4 | 58.9 | 59.4 | 60.0 |
| Italy | 2,326,893 | 47.2 | 47.5 | 47.3 | 47.8 | 47.8 | 47.9 | 47.5 |
| Mexico | 2,266,350 | 17.6 | 18.1 | 18.1 | 18.1 | 18.5 | 18.6 | 18.8 |
| Turkey | 2,007,466 | 30.7 | 32.4 | 33.1 | 35.3 | 35.3 | 36.5 | 36.8 |
| Korea, Rep. | 1,877,123 | 29.3 | 30.1 | 30.5 | 31.1 | 31.8 | 32.1 | 32.9 |
| Spain | 1,687,613 | 44.3 | 45.0 | 45.9 | 46.5 | 46.7 | 46.9 | 47.2 |
| Canada | 1,625,361 | 46.2 | 47.0 | 47.0 | 47.5 | 48.7 | 48.6 | 48.9 |
| Australia | 1,181,218 | 47.9 | 48.5 | 49.7 | 50.5 | 50.9 | 52.3 | 52.6 |
| Poland | 1,039,650 | 25.5 | 26.6 | 27.1 | 27.6 | 27.9 | 28.4 | 29.1 |
| Netherlands | 860,689 | 59.4 | 59.8 | 59.7 | 60.1 | 60.5 | 61.5 | 61.7 |
| Switzerland | 534,903 | 57.2 | 56.9 | 57.0 | 58.1 | 58.7 | 58.0 | 58.0 |
| Belgium | 525,969 | 63.2 | 62.9 | 62.8 | 63.2 | 63.8 | 64.6 | 64.6 |
| Sweden | 485,284 | 53.1 | 53.5 | 53.4 | 53.9 | 54.5 | 56.1 | 56.4 |
| Austria | 441,389 | 51.5 | 52.0 | 52.6 | 52.9 | 53.2 | 54.2 | 54.0 |
| Chile | 420,457 | 21.1 | 21.6 | 22.6 | 23.1 | 23.4 | 23.5 | 23.8 |
| Czech Republic | 367,172 | 31.9 | 32.5 | 32.6 | 32.6 | 33.0 | 34.7 | 34.7 |
| Ireland | 339,478 | 58.2 | 63.8 | 64.0 | 63.0 | 66.7 | 81.2 | 83.1 |
| Israel | 318,409 | 33.0 | 33.9 | 33.8 | 34.5 | 35.0 | 35.1 | 35.2 |
| Portugal | 316,564 | 31.4 | 31.8 | 32.1 | 32.5 | 32.2 | 32.2 | 32.4 |
| Norway | 307,834 | 76.8 | 76.2 | 76.8 | 77.4 | 77.8 | 78.9 | 79.2 |
| Greece | 288,418 | 33.0 | 31.9 | 31.3 | 31.1 | 31.6 | 31.1 | 30.9 |
| Denmark | 280,839 | 60.3 | 60.5 | 61.6 | 62.1 | 63.1 | 63.5 | 63.5 |
| Hungary | 262,042 | 30.6 | 31.2 | 31.0 | 31.4 | 31.1 | 31.4 | 31.1 |
| Finland | 238,376 | 50.3 | 51.1 | 50.3 | 50.6 | 50.6 | 50.6 | 51.7 |
| New Zealand | 185,218 | 35.9 | 36.6 | 37.9 | 37.3 | 37.1 | 38.2 | 37.9 |
| Slovak Republic | 165,424 | 34.4 | 35.0 | 35.7 | 36.8 | 37.6 | 38.4 | 39.1 |
| Slovenia | 67,575 | 35.2 | 36.4 | 36.2 | 35.8 | 36.3 | 36.5 | 37.4 |
| Luxembourg | 59,592 | 79.8 | 79.5 | 77.7 | 79.4 | 81.6 | 81.1 | 81.2 |
| Latvia | 50,137 | 22.6 | 23.5 | 24.3 | 24.4 | 25.1 | 25.9 | 26.6 |
| Estonia | 39,136 | 28.0 | 27.6 | 28.9 | 29.4 | 30.1 | 29.9 | 30.3 |
| Iceland | 17,022 | 49.0 | 49.2 | 49.7 | 50.7 | 51.0 | 51.7 | 53.7 |

# Australian GDP by Sub-industry

## $ Millions

Source: ABS

GDP $ Millions

| Industry | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| Agriculture, forestry and fishing ; Agriculture | 33,973 | 36,383 | 36,889 | 33,973 | 40,600 |
| Agriculture, forestry and fishing; Forestry and fishing | 6,365 | 6,148 | 6,216 | 6,365 | 6,769 |
| **Agriculture, forestry and fishing Total** | **40,338** | **42,520** | **43,092** | **40,338** | **47,369** |
| *Mining; Coal mining* | *17,223* | *16,064* | *16,959* | *17,223* | *17,370* |
| *Mining; Oil and gas extraction* | *24,266* | *20,866* | *21,567* | *24,266* | *26,802* |
| *Mining; Iron ore mining* | *32,874* | *25,244* | *29,147* | *32,874* | *35,113* |
| *Mining; Other mining* | *15,670* | *16,197* | *15,934* | *15,670* | *14,634* |
| Mining; Mining excluding exploration and mining support services | 90,033 | 76,147 | 82,932 | 90,033 | 93,920 |
| Mining; Exploration and mining support services | 7,622 | 10,460 | 9,385 | 7,622 | 6,331 |
| **Mining Total** | **97,655** | **85,598** | **91,961** | **97,655** | **100,251** |
| Manufacturing; Food, beverage and tobacco products | 25,391 | 26,632 | 25,936 | 25,391 | 26,391 |
| Manufacturing; Petroleum, coal, chemical and rubber products | 19,197 | 20,251 | 19,710 | 19,197 | 18,944 |
| Manufacturing; Metal products | 15,449 | 16,790 | 16,244 | 15,449 | 15,213 |
| Manufacturing; Machinery and equipment | 19,318 | 20,135 | 19,855 | 19,318 | 18,018 |
| Manufacturing; Other manufacturing | 21,341 | 20,826 | 21,377 | 21,341 | 20,425 |
| **Manufacturing Total** | **100,696** | **104,613** | **103,132** | **100,696** | **98,990** |
| Electricity, gas, water and waste services; Electricity | 22,742 | 22,452 | 22,457 | 22,742 | 22,729 |
| Electricity, gas, water and waste services; Gas | 1,758 | 1,524 | 1,637 | 1,758 | 1,781 |
| Electricity, gas, water and waste services; Water supply and waste services | 16,646 | 15,687 | 16,141 | 16,646 | 16,785 |
| **Electricity, gas, water and waste services Total** | **41,146** | **39,672** | **40,233** | **41,146** | **41,294** |
| Construction; Building construction | 27,369 | 25,066 | 26,120 | 27,369 | 27,708 |
| Construction; Heavy and civil engineering construction | 30,166 | 43,855 | 35,066 | 30,166 | 27,377 |
| Construction; Construction services | 72,367 | 65,379 | 69,862 | 72,367 | 69,868 |
| **Construction Total** | **129,902** | **134,607** | **131,099** | **129,902** | **124,953** |
| **Wholesale trade Total** | **66,971** | **62,451** | **64,476** | **66,971** | **70,770** |
| **Retail trade Total** | **74,541** | **69,230** | **71,584** | **74,541** | **75,810** |
| **Accommodation and food services Total** | **40,040** | **36,924** | **38,499** | **40,040** | **40,872** |
| Transport, postal and warehousing; Road | 24,315 | 23,800 | 24,132 | 24,315 | 24,558 |
| Transport, postal and warehousing; Air and space transport | 9,293 | 8,000 | 8,541 | 9,293 | 9,442 |
| Transport, postal and warehousing; Rail, pipeline and other transport | 11,666 | 10,960 | 11,471 | 11,666 | 11,872 |

GDP $ Millions

| Industry | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| Transport, postal and warehousing; Transport, postal and storage services | 34,808 | 35,367 | 34,448 | 34,808 | 35,659 |
| **Transport, postal and warehousing Total** | **80,082** | **78,182** | **78,574** | **80,082** | **81,530** |
| Information media and telecommunications; Telecommunications services | 22,463 | 18,957 | 20,647 | 22,463 | 24,431 |
| Information media and telecommunications; Other information and media services | 21,614 | 19,186 | 20,332 | 21,614 | 20,708 |
| **Information media and telecommunications Total** | **44,077** | **38,110** | **40,969** | **44,077** | **45,139** |
| Financial and insurance services; Finance | 102,081 | 94,171 | 98,682 | 102,081 | 105,904 |
| Financial and insurance services; Other financial and insurance services | 40,884 | 38,786 | 39,561 | 40,884 | 43,046 |
| **Financial and insurance services Total** | **142,965** | **132,948** | **138,243** | **142,965** | **148,950** |
| Rental, hiring and real estate services; Rental and hiring services | 6,935 | 6,774 | 6,702 | 6,935 | 7,515 |
| Rental, hiring and real estate services; Property operators and real estate services | 43,662 | 37,551 | 39,564 | 43,662 | 44,255 |
| **Rental, hiring and real estate services Total** | **50,597** | **44,370** | **46,286** | **50,597** | **51,770** |
| Professional, scientific and technical services; Computer system design and related services | 26,368 | 23,312 | 25,424 | 26,368 | 28,806 |
| Professional, scientific and technical services; Other professional, scientific and technical services | 82,169 | 79,592 | 79,300 | 82,169 | 86,068 |
| **Professional, scientific and technical services Total** | **108,537** | **102,797** | **104,723** | **108,537** | **114,874** |
| **Administrative and support services Total** | **53,572** | **50,688** | **52,199** | **53,572** | **53,509** |
| **Public administration and safety Total** | **91,129** | **87,319** | **87,940** | **91,129** | **93,019** |
| **Education and training Total** | **80,874** | **76,805** | **78,516** | **80,874** | **82,428** |
| **Health care and social assistance Total** | **113,061** | **102,750** | **108,603** | **113,061** | **119,782** |
| **Arts and recreation services Total** | **13,812** | **13,119** | **13,308** | **13,812** | **13,925** |
| **Other services Total** | **29,175** | **28,682** | **29,258** | **29,175** | **28,361** |
| **Ownership of dwellings Total** | **143,602** | **138,997** | **139,913** | **143,602** | **147,079** |
| Gross value added at basic prices ; | 1,542,772 | 1,466,087 | 1,501,481 | 1,542,772 | 1,580,676 |
| Taxes less subsidies on products | 116,832 | 110,839 | 112,443 | 116,832 | 118,232 |
| Statistical discrepancy | – | – | – | – | -4,425 |
| GDP | 1,659,604 | 1,576,897 | 1,613,972 | 1,659,604 | 1,694,483 |
| Additional discrepancy (subtotals not adding to totals) | – | 4,324 | 1,079 | – | -1 |
| **Grand Total GDP** | **1,659,604** | **1,581,221** | **1,615,051** | **1,659,604** | **1,694,482** |

## Industry and Sub-industry Overviews

Source: ABS

| | Income | | | | | Expenses | |
|---|---|---|---|---|---|---|---|
| | Sales and service income | Funding from government for operational costs | Interest income | Other income | Total income | Selected labour costs | Purchases of goods and materials |
| | $m | $m | $m | $m | $m | $m | $m |
| **Agriculture forestry and fishing** | | | | | | | |
| Agriculture | | | | | | | |
| 2013–14 | 65313 | 559 | 267 | 1686 | 67825 | 5562 | 29623 |
| 2014–15 | 73400 | 716 | 264 | 2701 | 77081 | 6400 | 35540 |
| 2015–16 | 80779 | 589 | 274 | 3667 | 85309 | 6504 | 42039 |
| Aquaculture | | | | | | | |
| 2013–14 | 1310 | | | 78 | 1402 | 245 | 606 |
| 2014–15 | 1352 | 14 | 2 | 39 | 1407 | 247 | 605 |
| 2015–16 | 1367 | 17 | 1 | 70 | 1455 | 275 | 695 |
| Forestry and logging | | | | | | | |
| 2013–14 | 3421 | | | 651 | 4197 | 557 | 855 |
| 2014–15 | 3644 | 73 | 11 | 449 | 4177 | 551 | 1055 |
| 2015–16 | 4777 | 96 | 15 | 607 | 5496 | 605 | 902 |
| Fishing hunting and trapping | | | | | | | |
| 2013–14 | 1914 | 40 | 21 | 65 | 2039 | 242 | 615 |
| 2014–15 | 2208 | 70 | 26 | 59 | 2363 | 256 | 733 |
| 2015–16 | 2516 | 41 | 15 | 141 | 2712 | 296 | 614 |
| Agriculture forestry and fishing support services | | | | | | | |
| 2013–14 | 5354 | 100 | 25 | 80 | 5558 | 1078 | 2121 |
| 2014–15 | 5658 | 47 | 14 | 63 | 5781 | 1144 | 2212 |
| 2015–16 | 5842 | 48 | 14 | 90 | 5994 | 1132 | 2182 |
| **Total Agriculture forestry and fishing** | | | | | | | |
| 2013–14 | 77313 | 820 | 329 | 2560 | 81021 | 7685 | 33820 |
| 2014–15 | 86262 | 920 | 317 | 3311 | 90809 | 8597 | 40145 |
| 2015–16 | 95281 | 791 | 319 | 4575 | 100966 | 8813 | 46432 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Mining** | | | | | | | |
| 2013–14 | 49012 | 775 | 488 | 140 | 50415 | 6744 | 10057 |
| 2014–15 | 45869 | 769 | 475 | -3383 | 43729 | 6489 | 10245 |
| 2015–16 | 44117 | 874 | 394 | -7212 | 38173 | 6251 | 10724 |

| | | | | | Profit | |
|---|---|---|---|---|---|---|
| Interest expenses | Depreciation and amortisation | Other selected expenses | Capital work done for own use | Total expenses | Operating profit before tax | Profit margin |
| $m | $m | $m | $m | $m | $m | % |
| | | | | | | |
| | | | | | | |
| 3619 | 2546 | 16306 | 126 | 57530 | 10097 | 15.5 |
| 3464 | 2884 | 15768 | 204 | 63851 | 13766 | 18.8 |
| 3474 | 3054 | 15285 | 170 | 70186 | 15301 | 18.9 |
| | | | | | | |
| 28 | | 273 | | 1210 | 284 | 21.7 |
| | 66 | 325 | | 1262 | 171 | 12.6 |
| 24 | 95 | 326 | 8 | 1408 | 56 | 4.1 |
| | | | | | | |
| 242 | | 1460 | | 3322 | 878 | 25.6 |
| 187 | 114 | 1348 | 16 | 3238 | 948 | 26 |
| 260 | 289 | 2358 | 19 | 4394 | 1113 | 23.3 |
| | | | | | | |
| 73 | 70 | 505 | 2 | 1503 | 545 | 28.5 |
| | 71 | 549 | | 1671 | 693 | 31.4 |
| 63 | 81 | 742 | 14 | 1783 | 926 | 36.8 |
| | | | | | | |
| 96 | 236 | 1392 | 2 | 4922 | 631 | 11.8 |
| 134 | 297 | 1363 | 6 | 5145 | 670 | 11.8 |
| 152 | 296 | 1340 | 15 | 5088 | 908 | 15.5 |
| | | | | | | |
| 4058 | 3147 | 19937 | 159 | 68488 | 12435 | 16.1 |
| 3871 | 3432 | 19352 | 231 | 75167 | 16247 | 18.8 |
| 3974 | 3815 | 20051 | 226 | 82859 | 18304 | 19.2 |
| | | | | | | |
| | | | | | | |
| 1219 | 6443 | 25261 | 466 | 49258 | 989 | 2 |
| 1213 | 5971 | 23835 | 249 | 47504 | -4077 | -8.9 |
| 1334 | 6329 | 21626 | 273 | 45991 | -8081 | -18.3 |

| | Income | | | | | Expenses | |
|---|---|---|---|---|---|---|---|
| | Sales and service income | Funding from government for operational costs | Interest income | Other income | Total income | Selected labour costs | Purchases of goods and materials |
| | $m | $m | $m | $m | $m | $m | $m |
| **Mining continued** | | | | | | | |
| Oil and gas extraction | | | | | | | |
| 2013–14 | 38928 | 57 | 888 | 5722 | 45596 | 4832 | 5759 |
| 2014–15 | 41369 | 68 | 1238 | -8816 | 33859 | 5097 | 6022 |
| 2015–16 | 34616 | 52 | 887 | -5153 | 30402 | 5170 | 6384 |
| Metal ore mining | | | | | | | |
| 2013–14 | 110326 | 740 | 929 | -2114 | 109881 | 11543 | 16245 |
| 2014–15 | 104129 | 913 | 1330 | -7351 | 99020 | 11096 | 16448 |
| 2015–16 | 90402 | 978 | 601 | -1058 | 90923 | 10696 | 14572 |
| Non-metallic mineral mining and quarrying | | | | | | | |
| 2013–14 | 6241 | 57 | 18 | 115 | 6430 | 1083 | 1304 |
| 2014–15 | 6094 | 58 | 18 | 7 | 6176 | 1100 | 1427 |
| 2015–16 | 6089 | 54 | 19 | 78 | 6239 | 1056 | 1351 |
| Exploration and other mining support services | | | | | | | |
| 2013–14 | 17071 | 180 | 134 | 1062 | 18447 | 5359 | 3213 |
| 2014–15 | 15865 | 125 | 606 | -2231 | 14364 | 5198 | 2915 |
| 2015–16 | 13719 | 116 | 124 | -362 | 13597 | 4316 | 2732 |
| **Total Mining** | | | | | | | |
| 2013–14 | 221578 | 1810 | 2458 | 4924 | 230770 | 29562 | 36578 |
| 2014–15 | 213326 | 1933 | 3666 | -21776 | 197149 | 28980 | 37055 |
| 2015–16 | 188943 | 2075 | 2024 | -13707 | 179334 | 27489 | 35763 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Manufacturing** | | | | | | | |
| Food product manufacturing | | | | | | | |
| 2013–14 | 81189 | 63 | 152 | 88 | 81493 | 11628 | 48962 |
| 2014–15 | 85562 | 52 | 172 | 507 | 86293 | 11944 | 53469 |
| 2015–16 | 86320 | 83 | 208 | 738 | 87349 | 12697 | 53189 |
| Beverage and tobacco product manufacturing | | | | | | | |
| 2013–14 | 18598 | 37 | | | 19186 | 2419 | 8282 |
| 2014–15 | 18063 | 63 | | | 18698 | 2531 | 8126 |
| 2015–16 | 17039 | 30 | | | 17906 | 2358 | 8064 |
| Textile leather clothing and footwear manufacturing | | | | | | | |
| 2013–14 | 7665 | 19 | 11 | 39 | 7734 | 1632 | 4083 |
| 2014–15 | 7984 | 47 | 15 | 38 | 8085 | 1609 | 4168 |
| 2015–16 | 7814 | 30 | 16 | 0 | 7861 | 1561 | 4058 |
| Wood product manufacturing | | | | | | | |
| 2013–14 | 10222 | | | 100 | 10363 | 2247 | 4999 |
| 2014–15 | 12041 | 29 | 26 | 56 | 12152 | 2436 | 6271 |

| | | | | | Profit | |
|---|---|---|---|---|---|---|
| Interest expenses | Depreciation and amortisation | Other selected expenses | Capital work done for own use | Total expenses | Operating profit before tax | Profit margin |
| $m | $m | $m | $m | $m | $m | % |
| | | | | | | |
| | | | | | | |
| 2375 | 7487 | 13118 | 4734 | 28837 | 16816 | 43.2 |
| 4428 | 8879 | 12119 | 5225 | 31319 | 2708 | 6.5 |
| 3902 | | 11324 | | 32346 | -2000 | -5.8 |
| | | | | | | |
| 2507 | 9963 | 38054 | 2385 | 75927 | 34190 | 31 |
| 3010 | 13085 | 35576 | 1916 | 77298 | 20298 | 19.5 |
| 2955 | 14068 | 31209 | 774 | 72725 | 17618 | 19.5 |
| | | | | | | |
| 94 | 348 | 3095 | 63 | 5862 | 625 | 10 |
| 92 | 400 | 2688 | 72 | 5634 | 524 | 8.6 |
| 229 | 447 | 2639 | 27 | 5694 | 531 | 8.7 |
| | | | | | | |
| 708 | 1808 | 8067 | 208 | 18947 | -411 | -2.4 |
| 536 | 1430 | 7280 | 108 | 17250 | -2927 | -18.4 |
| 468 | | 5548 | | 14309 | -991 | -7.2 |
| | | | | | | |
| 6903 | 26050 | 87595 | 7857 | 178831 | 52208 | 23.6 |
| 9280 | 29764 | 81497 | 7569 | 179006 | 16526 | 7.7 |
| 8888 | 33111 | 72345 | 6531 | 171065 | 7077 | 3.7 |
| | | | | | | |
| | | | | | | |
| 766 | 1754 | 15094 | 220 | 77985 | 3662 | 4.5 |
| 798 | 1777 | 14846 | 250 | 82584 | 4398 | 5.1 |
| 753 | 1768 | 14365 | 202 | 82569 | 4998 | 5.8 |
| | | | | | | |
| 816 | 864 | 3189 | 12 | 15559 | 3827 | 20.6 |
| 884 | 967 | 3558 | 33 | 16034 | 3023 | 16.7 |
| 1069 | 754 | 3693 | 22 | 15917 | 2257 | 13.2 |
| | | | | | | |
| 69 | 136 | 1309 | 4 | 7226 | 600 | 7.8 |
| 51 | 118 | 1439 | 3 | 7382 | 767 | 9.6 |
| 44 | 104 | 1526 | 5 | 7287 | 623 | 8 |
| | | | | | | |
| | 223 | 1891 | | 9462 | 889 | 8.7 |
| 67 | 229 | 2332 | 11 | 11325 | 917 | 7.6 |

| | Income | | | | | Expenses | |
|---|---|---|---|---|---|---|---|
| | Sales and service income | Funding from government for operational costs | Interest income | Other income | Total income | Selected labour costs | Purchases of goods and materials |
| | $m | $m | $m | $m | $m | $m | $m |
| **Manufacturing continued** | | | | | | | |
| 2015–16 | 13195 | 54 | 12 | 156 | 13417 | 2575 | 6331 |
| Pulp paper and converted paper product manufacturing | | | | | | | |
| 2013–14 | 9788 | 9 | | | 9937 | 1623 | 5702 |
| 2014–15 | 10128 | 11 | 13 | 22 | 10174 | 1648 | 5854 |
| 2015–16 | 10479 | 1 | | | 10714 | 1659 | 6229 |
| Printing (including the reproduction of recorded media) | | | | | | | |
| 2013–14 | 8265 | | | -69 | 8232 | 2256 | 3351 |
| 2014–15 | 9207 | 2 | | | 9295 | 2652 | 3434 |
| 2015–16 | 8386 | 2 | | | 8460 | 2332 | 3276 |
| Petroleum and coal product manufacturing | | | | | | | |
| 2013–14 | 27126 | | | -308 | 26833 | 702 | 24322 |
| 2014–15 | 23055 | 53 | 14 | -298 | 22824 | 705 | 19355 |
| 2015–16 | 15807 | 69 | 2 | 52 | 15930 | 717 | 11764 |
| Basic chemical and chemical product manufacturing | | | | | | | |
| 2013–14 | 30123 | 114 | 111 | 113 | 30462 | 4407 | 17150 |
| 2014–15 | 31792 | 29 | 109 | 13 | 31943 | 4377 | 17894 |
| 2015–16 | 31430 | 32 | 116 | 507 | 32085 | 4428 | 16538 |
| Polymer product and rubber product manufacturing | | | | | | | |
| 2013–14 | 14017 | 13 | 15 | 84 | 14128 | 2916 | 6835 |
| 2014–15 | 13998 | 27 | 13 | 82 | 14120 | 2762 | 7319 |
| 2015–16 | 14341 | 86 | 76 | 104 | 14608 | 2878 | 7129 |
| Non-metallic mineral product manufacturing | | | | | | | |
| 2013–14 | 17990 | 37 | 36 | 209 | 18272 | 3185 | 8097 |
| 2014–15 | 19325 | 45 | 37 | 185 | 19592 | 3353 | 8851 |
| 2015–16 | 19834 | 56 | 29 | 223 | 20143 | 3458 | 9076 |
| Primary metal and metal product manufacturing | | | | | | | |
| 2013–14 | 48660 | 399 | 176 | -17 | 49219 | 5393 | 38163 |
| 2014–15 | 44569 | 170 | 192 | -740 | 44190 | 4732 | 32081 |
| 2015–16 | 48355 | 56 | 110 | 1304 | 49824 | 4502 | 37194 |
| Fabricated metal product manufacturing | | | | | | | |
| 2013–14 | 32307 | 29 | 41 | 182 | 32559 | 7579 | 15868 |
| 2014–15 | 29588 | 314 | 35 | 216 | 30153 | 7072 | 14656 |
| 2015–16 | 28597 | 13 | 195 | 159 | 28964 | 6623 | 14881 |
| Transport equipment manufacturing | | | | | | | |
| 2013–14 | 30772 | 264 | 331 | 151 | 31518 | 6321 | 18353 |

| | | | | | Profit | |
|---|---|---|---|---|---|---|
| Interest expenses | Depreciation and amortisation | Other selected expenses | Capital work done for own use | Total expenses | Operating profit before tax | Profit margin |
| $m | $m | $m | $m | $m | $m | % |
| | | | | | | |
| 56 | 214 | 3199 | 21 | 12355 | 1112 | 8.4 |
| | | | | | | |
| 61 | 457 | 1570 | 3 | 9410 | 576 | 5.9 |
| | 397 | 1732 | | 9666 | 513 | 5.1 |
| 35 | 381 | 1780 | 2 | 10081 | 568 | 5.4 |
| | | | | | | |
| | 290 | 1831 | | 7823 | 459 | 5.6 |
| 60 | 395 | 1823 | 8 | 8355 | 933 | 10.1 |
| 52 | 304 | 1807 | 10 | 7762 | 732 | 8.7 |
| | | | | | | |
| | 502 | 1249 | | 26800 | 85 | 0.3 |
| 39 | 316 | 1513 | 6 | 21922 | -326 | -1.4 |
| 14 | 212 | 1340 | 3 | 14045 | 920 | 5.8 |
| | | | | | | |
| 420 | 1271 | 5081 | 212 | 28118 | 2377 | 7.9 |
| 392 | 1282 | 5354 | 129 | 29170 | 2752 | 8.7 |
| 368 | 1395 | 5970 | 152 | 28546 | 3458 | 11 |
| | | | | | | |
| 109 | 398 | 3021 | 10 | 13268 | 863 | 6.2 |
| 94 | 332 | 2680 | 21 | 13166 | 1068 | 7.6 |
| 98 | 358 | 2837 | 19 | 13281 | 1201 | 8.4 |
| | | | | | | |
| 155 | 712 | 4598 | 38 | 16710 | 1550 | 8.6 |
| | 682 | 4911 | | 17852 | 1739 | 9 |
| 157 | 699 | 5249 | 35 | 18604 | 1724 | 8.7 |
| | | | | | | |
| 680 | 1978 | 5876 | 118 | 51972 | -2867 | -5.9 |
| 364 | 1847 | 5680 | 200 | 44503 | -369 | -0.8 |
| 303 | 1618 | 5591 | 35 | 49172 | 1123 | 2.3 |
| | | | | | | |
| 202 | 555 | 6631 | 178 | 30657 | 2039 | 6.3 |
| 218 | 615 | 5473 | 36 | 27996 | 2184 | 7.4 |
| 133 | 613 | 4868 | 29 | 27090 | 2013 | 7 |
| | | | | | | |
| 438 | 899 | 5302 | 16 | 31298 | 356 | 1.2 |

| | Income | | | | | Expenses | |
|---|---|---|---|---|---|---|---|
| | Sales and service income | Funding from government for operational costs | Interest income | Other income | Total income | Selected labour costs | Purchases of goods and materials |
| | $m | $m | $m | $m | $m | $m | $m |
| **Manufacturing continued** | | | | | | | |
| 2014–15 | 28394 | 174 | 321 | 30 | 28920 | 6389 | 16305 |
| 2015–16 | 27760 | 127 | 578 | -53 | 28412 | 5464 | 16245 |
| Machinery and equipment manufacturing | | | | | | | |
| 2013–14 | 33086 | 21 | 193 | 208 | 33507 | 7803 | 17524 |
| 2014–15 | 32062 | 13 | 195 | 727 | 32998 | 7486 | 16610 |
| 2015–16 | 33299 | 19 | 102 | 331 | 33751 | 7929 | 15649 |
| Furniture and other manufacturing | | | | | | | |
| 2013–14 | 7617 | | | 65 | 7713 | 1535 | 4385 |
| 2014–15 | 7904 | 36 | 10 | 44 | 7994 | 1731 | 4340 |
| 2015–16 | 8881 | 5 | 10 | 35 | 8931 | 1806 | 4916 |
| **Total manufacturing** | | | | | | | |
| 2013–14 | 377425 | 1058 | 1553 | 1119 | 381156 | 61647 | 226077 |
| 2014–15 | 373673 | 1064 | 1580 | 1116 | 377432 | 61424 | 218732 |
| 2015–16 | 371538 | 664 | 2014 | 4141 | 378357 | 60987 | 214538 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | |
| Building construction | | | | | | | |
| 2013–14 | 123791 | 65 | 624 | 1297 | 125777 | 10697 | 61291 |
| 2014–15 | 134246 | 45 | 604 | 1500 | 136395 | 11364 | 61646 |
| 2015–16 | 146069 | 31 | 492 | 2042 | 148633 | 12724 | 68940 |
| Heavy and civil engineering construction | | | | | | | |
| 2013–14 | 86248 | 450 | 268 | 973 | 87939 | 19906 | 22258 |
| 2014–15 | 83182 | 575 | 223 | 1214 | 85194 | 18169 | 22430 |
| 2015–16 | 67824 | 314 | 310 | 224 | 68672 | 16421 | 17259 |
| Construction services | | | | | | | |
| 2013–14 | 145454 | 213 | 1255 | 674 | 147596 | 34996 | 45446 |
| 2014–15 | 155791 | 508 | 309 | 379 | 156987 | 37058 | 53361 |
| 2015–16 | 159071 | 302 | 277 | 798 | 160449 | 38538 | 49905 |
| **Total construction** | | | | | | | |
| 2013–14 | 355493 | 729 | 2147 | 2944 | 361312 | 65599 | 128995 |
| 2014–15 | 373218 | 1128 | 1136 | 3093 | 378576 | 66591 | 137437 |
| 2015–16 | 372964 | 647 | 1080 | 3064 | 377754 | 67682 | 136103 |

| | | | | | Profit | |
|---|---|---|---|---|---|---|
| Interest expenses | Depreciation and amortisation | Other selected expenses | Capital work done for own use | Total expenses | Operating profit before tax | Profit margin |
| $m | $m | $m | $m | $m | $m | % |
| | | | | | | |
| 402 | 519 | 4987 | 42 | 28560 | 111 | 0.4 |
| 621 | 583 | 4981 | 47 | 27847 | 308 | 1.1 |
| | | | | | | |
| 265 | 603 | 4596 | 52 | 30740 | 2376 | 7.2 |
| 337 | 723 | 5336 | 71 | 30421 | 2686 | 8.4 |
| 280 | 629 | 6467 | 71 | 30884 | 3027 | 9.1 |
| | | | | | | |
| | 90 | 1168 | | 7234 | 550 | 7.2 |
| 42 | 78 | 1305 | 8 | 7488 | 554 | 7 |
| 99 | 88 | 1471 | 13 | 8366 | 707 | 8 |
| | | | | | | |
| 4279 | 10734 | 62407 | 883 | 364261 | 17341 | 4.6 |
| 3950 | 10277 | 62968 | 928 | 356424 | 20949 | 5.6 |
| 4082 | 9719 | 65144 | 666 | 353804 | 24771 | 6.7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1989 | 746 | 40178 | 17 | 114884 | 9194 | 7.4 |
| 2727 | 631 | 47859 | 107 | 124120 | 9219 | 6.9 |
| 2125 | | 49081 | | 133497 | 13028 | 8.9 |
| | | | | | | |
| 590 | 1554 | 39750 | 34 | 84023 | 4228 | 4.9 |
| 537 | 1281 | 37512 | 9 | 79921 | 5135 | 6.2 |
| 638 | | 30971 | | 66257 | 2121 | 3.1 |
| | | | | | | |
| 1623 | 2428 | 43198 | 46 | 127645 | 19190 | 13.2 |
| 1464 | 3303 | 39457 | 165 | 134478 | 21790 | 14 |
| 1468 | 2169 | 44833 | 224 | 136688 | 23670 | 14.9 |
| | | | | | | |
| 4202 | 4728 | 123126 | 97 | 326552 | 32612 | 9.2 |
| 4729 | 5216 | 124828 | 281 | 338520 | 36144 | 9.7 |
| 4232 | 4318 | 124885 | 778 | 336442 | 38819 | 10.4 |

| | Income | | | | | Expenses | |
|---|---|---|---|---|---|---|---|
| | Sales and service income | Funding from government for operational costs | Interest income | Other income | Total income | Selected labour costs | Purchases of goods and materials |
| | **$m** | **$m** | **$m** | **$m** | **$m** | **$m** | **$m** |
| **Health Care** | | | | | | | |
| Hospitals (private) | | | | | | | |
| 2013–14 | 12566 | 2740 | 41 | 413 | 15760 | 7677 | 3583 |
| 2014–15 | 13011 | 2279 | 43 | 784 | 16118 | 7892 | 3250 |
| 2015–16 | 14457 | 2437 | 34 | 857 | 17785 | 8815 | 3413 |
| Medical and other health care services (private) | | | | | | | |
| 2013–14 | 48466 | 4393 | 174 | 1044 | 54078 | 16253 | 4386 |
| 2014–15 | 55597 | 3175 | 186 | 1273 | 60231 | 18046 | 4961 |
| 2015–16 | 55914 | 3758 | 89 | 1638 | 61399 | 18963 | 5943 |
| Residential care services (private) | | | | | | | |
| 2013–14 | 5586 | 11334 | 557 | 1555 | 19032 | 11393 | 1341 |
| 2014–15 | 6144 | 12050 | 622 | 1720 | 20536 | 11404 | 1681 |
| 2015–16 | 7305 | 13834 | 493 | 1356 | 22989 | 12873 | 2034 |
| Social assistance services (private) | | | | | | | |
| 2013–14 | 7246 | 9736 | 144 | 1771 | 18898 | 11249 | 1145 |
| 2014–15 | 9713 | 10665 | 175 | 2112 | 22666 | 13570 | 1356 |
| 2015–16 | 10213 | 10197 | 126 | 2300 | 22836 | 13752 | 1314 |
| **Total health care and social assistance (private)** | | | | | | | |
| 2013–14 | 73865 | 28203 | 917 | 4783 | 107768 | 46572 | 10455 |
| 2014–15 | 84465 | 28170 | 1026 | 5889 | 119551 | 50912 | 11248 |
| 2015–16 | 87890 | 30227 | 743 | 6151 | 125010 | 54403 | 12703 |

| | | | | | Profit | |
|---|---|---|---|---|---|---|
| Interest expenses | Depreciation and amortisation | Other selected expenses | Capital work done for own use | Total expenses | Operating profit before tax | Profit margin |
| **$m** | **$m** | **$m** | **$m** | **$m** | **$m** | **%** |
| | | | | | | |
| | | | | | | |
| | 528 | 2981 | | 14885 | 889 | 7.1 |
| 108 | 580 | 3570 | 61 | 15340 | 839 | 6.4 |
| 108 | 631 | 4197 | 158 | 17007 | 816 | 5.6 |
| | | | | | | |
| 721 | 1498 | 16062 | 25 | 38895 | 15166 | 31.3 |
| 568 | 1487 | 17246 | 184 | 42124 | 18136 | 32.6 |
| 421 | 1427 | 16244 | 139 | 42858 | 18563 | 33.2 |
| | | | | | | |
| 285 | 1000 | 3523 | 49 | 17494 | 1573 | 28.2 |
| 388 | 1030 | 3889 | 93 | 18299 | 2272 | 37 |
| 232 | 1056 | 4369 | 124 | 20440 | 2573 | 35.2 |
| | | | | | | |
| | 408 | 4474 | | 17326 | 1579 | 21.8 |
| 71 | 420 | 5425 | 17 | 20825 | 1844 | 19 |
| 94 | 420 | 5301 | 22 | 20859 | 1985 | 19.4 |
| | | | | | | |
| 1278 | 3434 | 27041 | 180 | 88599 | 19207 | 26 |
| 1135 | 3517 | 30130 | 355 | 96587 | 23091 | 27.3 |
| 856 | 3535 | 30112 | 443 | 101165 | 23936 | 27.2 |

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