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DIGITAL PULSE

ACS Australia's Digital Pulse 2019

Booming today, but how can we sustain digital workforce growth?

Deloitte Access Economics

Foreword

There are three pillars to the ACS strategy; ***Capacity*** is about ensuring there are sufficient technology professionals in Australia to underpin a successful digital economy and be the fuel that materially lift living standards, ***Capability*** is about enabling productive Australian industries and ensuring that the skills available in the profession are higher up the value chain in order to attract higher paying jobs, while ***Catalyst*** relates to sparking innovation by facilitating tech R&D and supporting Australian technology commercialisation.

ACS Australia's Digital Pulse is an annual snapshot on the state of Australia's digital economy. ***Capacity*** and ***Capability*** remain a focus of the snapshot where we look at employments and education trends in technology occupations. This year, we wanted to explore ***Catalyst*** in depth and the types of policy levers that could deliver a material lift in living standards.

In doing so, we ask a number of fundamental questions:

- Digitally enabled growth requires investments in new technologies. Capital is globally mobile. Is Australia an internationally competitive destination that will attract the investment required to drive future growth and innovation?
- How may government foster innovative ecosystems by directing and regulating markets?
- To what degree do different rates of technology investment and adoption determine productivity and living standards growth?
- How well suited is Australia's tax policy framework to digital investments?
- While university technology course completions have been seen slight growth, the future forecast for technology skills has not materially changed over the last four years. Previously we have investigated skills migration and overseas student participation in Australia's university system. This year, we seek to analyse the economics of reskilling.

Finally, with the large infrastructure commitments across Federal and State Governments, we undertake a case study investigating the economic benefits of Smart Cities and Smart Infrastructure.

Our thanks once again to the team at Deloitte Access Economics for their investigation into these areas, and we look forward to ACS Australia's Digital Pulse 2019 again being a catalyst for positive change and future economic impact in our nation.

Yohan Ramasundara
President

Andrew Johnson
Chief Executive Officer

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Executive summary

Digital technologies continue to provide Australian businesses, governments, individuals and communities with opportunities to grow and innovate. As emerging technologies become more integrated into the operations of our businesses and everyday lives of Australian citizens, we are finding new ways to increase our productivity and improve our living standards. Australia's future prosperity in an increasingly digitised world will depend upon ongoing investment in these technologies and further development in the digital skills required to operate them.

The **ACS Australia's Digital Pulse** is an annual stocktake of Australia's digital economy and workforce. Prepared by Deloitte Access Economics for the Australian Computer Society, the series provides a detailed examination of digital workforce trends, aimed at informing public debate about this important area of our economy.

This 2019 edition forecasts that **demand for technology workers will grow by 100,000 between 2018 and 2024** in trend terms, with the technology workforce increasing to 792,000 workers. Demand for technology workers will come from all sectors – while the Information and Communications Technology (ICT) industry itself will demand over 43,000 additional technology workers, there will also be an additional 19,000 technology workers in professional services and the fastest growth will be in health care, whose technology workforce will grow by over 50%. The continued strong demand comes after seven years of 2.5% average annual growth; far above the overall Australian labour market of 1.7%.

Meeting the voracious demands for more technology workers from Australia's businesses will be a huge challenge. The good news is that Australia's **pipeline of technology workers and skills is gradually improving.** Enrolments in IT degrees by domestic university students have increased by over 50% since the low of the late 2000s, with over 36,000 enrolments and almost 6,000 degree completions in 2017. And for the first time since the *Digital Pulse* has been published, female representation in the technology workforce has increased, albeit slightly, to 29% in 2018. The gender pay gap in technology occupations has also declined a little to 18%.

However, there is lead time before a higher pipeline of university graduates is able to benefit overall technology worker supply. Skilled workers from overseas are therefore an important source of technology skills for Australian businesses in the short term. Despite this, only 9,900 temporary skilled visas were granted to technology workers in 2017-18, 26% fewer than the previous year. This decline is likely related to the replacement of the 457 visa with the Temporary Skill Shortage visa over this period. In this context, there could still be challenges in filling the additional 100,000 technology jobs that will be created by Australian businesses by 2024.

More will therefore be needed for Australia to reap the full benefits of digital innovation. The dividend of greater development and use of technology is not simply recording a better rank on an esoteric technology leader-board or increasing the profitability of a few technology firms; a successful digital economy can materially lift living standards and quality of life for the whole country.

Consider first the dollar benefits on the table. The *ACS Australia's Digital Pulse* finds that digital technologies continue to power Australia's economic growth, as illustrated by the 29% increase in ICT services exports to $3.8 billion in 2017-18. More broadly, the contribution of digital to GDP is expected to grow 40% between 2018 and 2023, with that powered by mobile technology reaching $65 billion by 2023. That translates into the equivalent of an extra $2,500 for every person in Australia every year.

Moreover, there are non-monetary benefits such as better quality services, increased choice and lower travel times from digital technology. This edition showcases how **smart city technologies** have the potential to significantly improve quality of life by easing traffic congestion in our major cities. If we can use smart city solutions to keep Australia to a low-congestion scenario between now and 2030, the total benefits due to improved travel times could be the equivalent of almost $10 billion. Implementing technology solutions across all industries in the Australian economy is required to ensure that everyone can benefit from the welfare gains associated with digital advancement.

The **highest policy priority for the digital economy is skills development.** While there are various pathways for entering Australia's technology workforce, relying on IT graduates and skilled migration alone is unlikely to meet the significant future demand for technology workers. This means we need more people to consider moving from other occupations to take one of the additional 100,000 jobs that will be created in technology by 2024, which requires greater investment in developing workers' technology skills. The benefit from reskilling workers in other professional industries to meet employer demand for technology skills by 2024 could potentially be more than $11,000 per employee per year.

Digitally enabled growth also requires **investments in new technologies.** Capital is globally mobile, and Australia must be an internationally competitive destination in order to attract the investment required to drive future growth and innovation.

A stylised comparison of tax rates suggests that the Australian landscape for businesses' digital investment may be less favourable than some developed countries. For example, we have an effective return of 18.5% for investments in early-stage tech companies (compared to 38.6% in the UK), and an effective tax rate of 13% for companies investing in R&D (compared to 0% in Canada). Moreover, other countries outperform Australia in government investments in emerging technologies, such as artificial intelligence (AI): Australia's $29.9 million commitment to AI programs over the next four years is significantly exceeded by multi-billion dollar funding commitments in France and South Korea.

Australia is also relatively **'middle of the pack' when it comes to our start-up landscape.** While there were more than 1,700 start-ups in Australia in early 2019, we rank lower than countries like Canada, the US, Germany and the UK on measures such as availability of finance, commercial and professional infrastructure, and government support and policies. A recent international comparison ranked Sydney as number 23 in the top 30 global start-up ecosystems (a decline of 6 places compared to the previous year), and Melbourne outside this top 30 – suggesting Australia could be doing more to facilitate start-up activity.

Maximising Australia's potential for digital success requires concerted efforts in addressing our challenges on technology-related skills, investment and collaboration. This includes actions not only by government, but also on the part of businesses and individuals as well. Some of the **priority actions to maximise Australia's digital economic dividend** that are highlighted in this year's *Digital Pulse* include:

Developing Australia's technology workforce

- Improving the flexibility of learning programs to train workers in digital skills, such as mastery-based learning and better recognition of shorter flexible courses as formal credentials.
- More investment in developing workers' foundational literacy, numeracy and digital skills as prerequisites for technology-related reskilling.
- Considering different options for funding digital reskilling, such as lifelong learning accounts or subsidising employers to provide related training, as well as co-design and delivery between education providers, government and businesses.

Growing Australia's smart cities

- Greater public and private investment in improving core smart city infrastructure like affordable, low-bandwidth wireless networks and sensors in our cities.
- More technical support and funding for smart city initiatives at the local level, such as via the Federal Government's City Deals.
- Developing 'standards roadmaps' to reduce compliance burdens and improve the interoperability of smart city technologies.

Attracting more digital investment to Australia

- Reducing the gap between Australia's tax settings and regimes in other countries (e.g. for R&D), to provide a competitive landscape for incentivising digital investment.
- Improving the start-up landscape in Australian cities to catch up with opportunities available in other countries, including by enabling better access to finance and commercial infrastructure for entrepreneurs.

1

Introduction

ACS Australia's Digital Pulse provides a snapshot of Australia's digital economy, workforce and policy landscape, prepared by Deloitte Access Economics on behalf of the Australian Computer Society. Its analysis on Australia's ICT sector, the increasing use of digital technologies across the economy, and key enablers of future growth and innovation provides a platform and evidence base for the broader public discussion on digital issues.

Previous editions of the *Digital Pulse* have examined digital technology education in Australian schools, policy priorities to enable Australia's future digital growth, and Australia's international competitiveness in ICT relative to other developed countries. The series has also highlighted how emerging technologies are being applied to transform business operations in a diverse range of Australian industries, such as agriculture, health, manufacturing and financial services.

The 2019 report represents the fifth edition in the *Digital Pulse* series. In addition to profiling Australia's digital economy and workforce, this year's *Digital Pulse* includes deeper dives into industry skills demand and shortages, enabling ICT reskilling, smart city solutions for congestion, digital tax policy and Australia's start-up landscape. Our research is based on information from a range of sources, including:

- Data from the Australian Bureau of Statistics, both from publicly available tables and a customised data request on the technology workforce;
- Data and reports published by various Australian sources, particularly Australian Government Departments such as Education, Immigration and Industry;
- Data on the Australian start-up landscape collected by Upwise on behalf of the Australian Computer Society; and
- Consultations with industry and government experts in the technology workforce and digital economy, including from Knowledge Society, the Minerals Council of Australia, the Australian Digital Health Agency and an interview with renowned economist Paul Krugman.

The remainder of this report is structured as follows:

- Section 2 is a snapshot of Australia's current technology workforce and skills, including analysis on diversity in technology workers, as well as providing an overview of technology-related business activity.
- Section 3 includes forecasts of future employer demand for technology workers, and highlights industry hot spots where there is particularly strong demand for technology skills.
- Section 4 describes the economic dimensions of greater adoption of digital technology in Australia, including a spotlight on the opportunities of smart city solutions for congestion.
- Section 5 discusses some key digital policy issues, including the need for technology reskilling, the start-up landscape and the tax environment for technology-related investments.

With digital technologies continuing to see increased use by Australian households, businesses and governments, it is important that we have a robust and informed conversation about Australia's digital economy in order to drive growth and innovation in the future.

2

Snapshot of ICT in Australia

Key findings

2.5%

Australia's technology workforce has seen **average trend growth** of 2.5% per annum between 2011 and 2018, outpacing growth in the overall Australian labour market of 1.7% over this period.

36,335

Annual IT enrolments at universities are 50 per cent higher than a decade ago, reaching 36,335 in 2017.

29%

The **female share** of total technology workers in 2018 increased slightly to 29%, with the gender pay gap declining slightly from 20% in 2017 to 18% in 2018.

$3.78b

ICT services exports grew from $2.93b in 2016-17 to $3.78b in 2017-18. As a result, the ICT services trade surplus increased from $170m to $515m.

2.1 Technology-related occupations, industries and skills

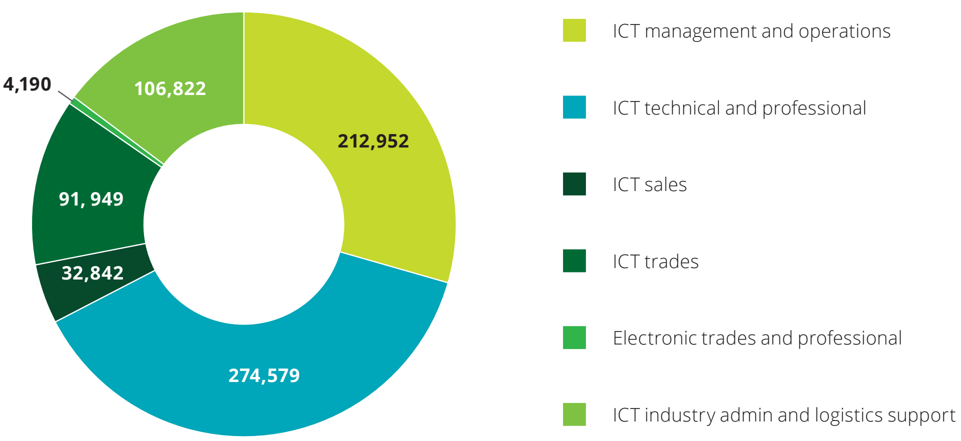
There continues to be significant demand for technology workers and skills across the Australian economy. In trend terms, Australia's technology workforce has grown by an average of 2.5% per annum between 2011 and 2018, outpacing the average growth of the overall Australian labour market of 1.7% over this period.[1,2]

According to raw ABS statistics, the size of the technology workforce was an estimated 723,334 workers in 2018. However, this represents significantly higher annual growth in technology workers compared to recent years, at an increase of more than 60,000 workers (9.1%) from the 663,100 workers reported in 2017 (DAE, 2018a).

This suggests that the 2018 estimate should be interpreted with caution: while the larger-than-expected increase could partially reflect increased demand for technology skills by Australian employers, it is also likely to be partly attributable to year-on-year volatility due to sampling issues in the employment data series reported by the ABS.

Technology occupations relating to technical, professional and operational roles continue to make up around two-thirds of all technology workers (Chart 2.1) and accounted for 42,328 of the growth in technology workers between 2017 and 2018. Overall, the technology workforce's share of Australia's total workforce increased from 5.4% in 2017 to 5.7% in 2018, emphasising the increasing importance of the technology workforce to the wider economy.

Chart 2.1: Technology workers by CIIER occupation groupings, 2018



Source: ABS customised report (2019)

1. ABS industry classifications include an 'Information Media and Telecommunications' (IMT) industry. However, in practice there are a large number of technology workers outside the IMT industry (for example, software developers working in the banking industry) and there are some employees in the IMT industry who are not technology workers (for example, publishers of print newspapers). In this study, employment figures for technology workers have been calculated using ABS occupation and industry classifications, based on the methodology used in previous editions of *Australia's Digital Pulse*. This methodology draws upon definitions and nomenclature developed by Centre for Innovative Industries Economic Research (CIIER) lead researcher, Ian Dennis FACS, and used in the ACS's 2008–13 statistical compendiums and other CIIER analysis. For a list of which occupations and industries have been classified as technology workers, refer to Table A.3.

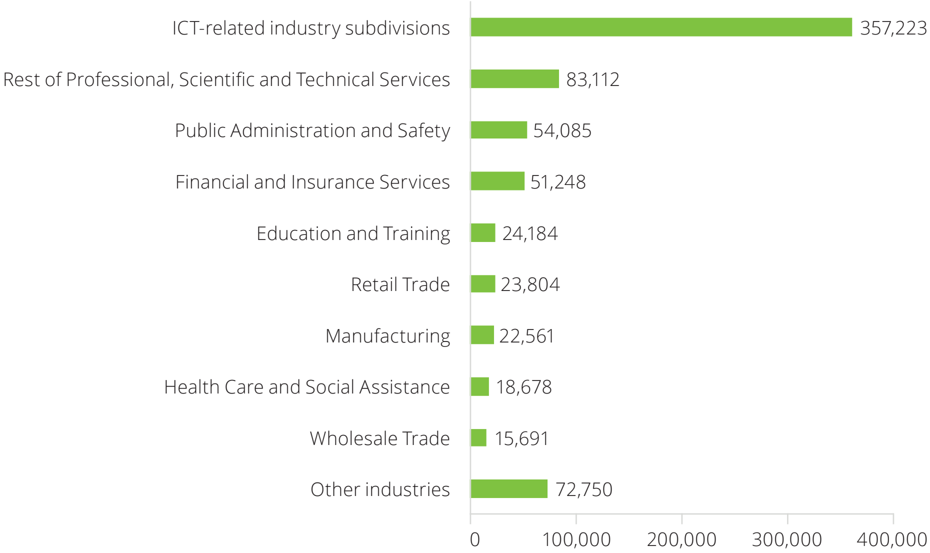
2. In this report, we use the term "technology workforce" to describe the group of workers previously called the "ICT workforce" in past editions of *Australia's Digital Pulse.*

Similar to previous editions of *Australia's Digital Pulse,* almost half (49%) of all technology workers are directly employed in ICT-related industries, such as computer system design, telecommunication services and internet service provision. The remaining 51% are employed in other industries throughout the Australian economy (Chart 2.2). The largest employer outside of ICT-related industries continues to be the professional, scientific and technical services, which employs 83,112 technology workers and has grown by 10,312 workers over the past year.

2.2 Diversity in the technology workforce

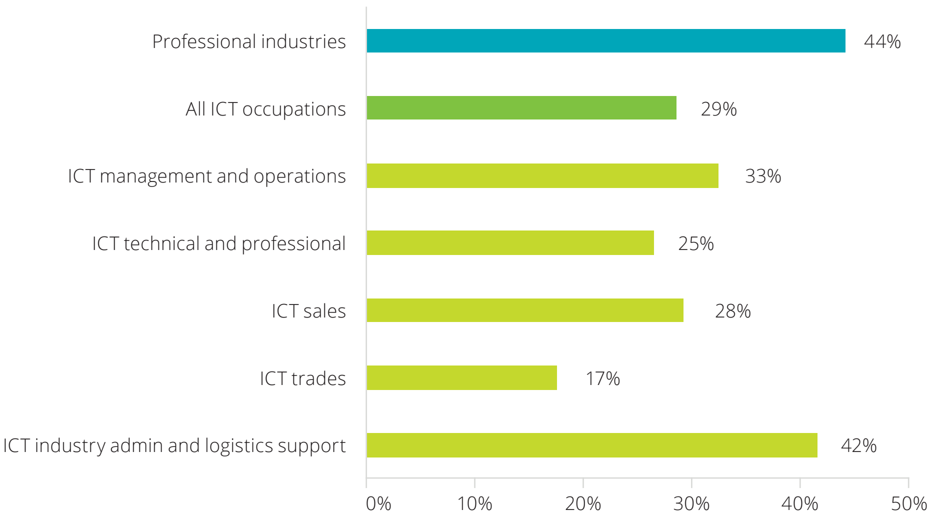
The technology workforce continues to see underrepresentation in key demographic segments. The participation of women in technology roles is 29% of the overall workforce, remaining significantly lower than it is in professional occupations more broadly, at 44% (Chart 2.3). However, there has been a small sign of improvement over the most recent year of data: the 29% share of females in technology roles represented a marginal increase of 1 percentage point relative to 2017 – the first increase in female representation in the technology workforce since *Australia's Digital Pulse* was first published in 2015.

Chart 2.2: Technology workers by industry, 2018



Source: ABS customised report (2019)

Chart 2.3: Share of women in technology occupations, 2018*

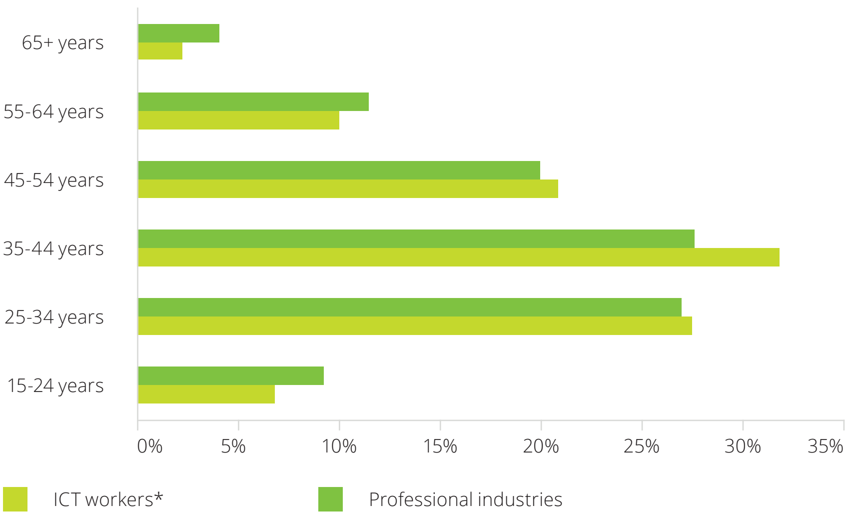


* Data for the electronic trades and professional ICT occupational grouping was unavailable
Source: ABS customised report (2019)

Chart 2.4: Gender pay gap in technology occupations, 2018

* Includes full-time and part-time workers
** Excludes ICT industry admin and logistics support for which breakdowns are unavailable; electronic trades and professional data is for all industries
Source: ABS catalogue 6306.0 (2019); ABS customised report (2019)

Chart 2.5: Age profile of technology workers, 2018



Source: ABS customised report (2019)
* Excludes ICT industry admin and logistic support, for which breakdowns are unavailable; electronic and trades and professional data is for all industries

Moreover, there continues to be a significant difference in the average earnings of male and female technology workers in Australia, with an average pay gap of around 18% across all technology occupations (Chart 2.4). At the same time, this again represents a marginal improvement on previous years, with previous *Digital Pulse* reports finding a gender pay gap of 20% in technology roles (DAE, 2018).

While these small improvements in the representation and remuneration of women in the technology workforce are welcome developments, the size of the gender discrepancies across the workforce suggest that there is still some way to go towards improving gender diversity in technology in Australia. Consistent with this, the 2019-20 Budget includes $3.4 million of funding to encourage more women into Science, Technology, Engineering and Mathematics (STEM) education and careers.

Older workers also continue to be underrepresented in Australia's technology workforce (Chart 2.5). Although the number of technology workers aged 55+ increased by 9,515 between 2017 and 2018, their share of total technology workers has remained at 12%, the same as reported in last year's *Digital Pulse*. Workers across all professional industries in the same age bracket saw their employment share increase over the same period, from 15% to 16%.

2.3 Supply of technology workers in Australia

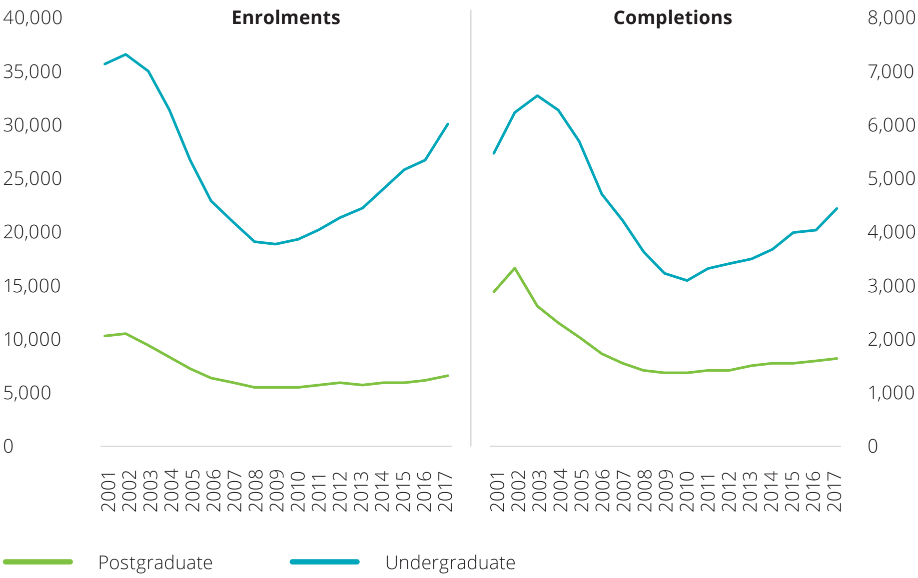
Total domestic enrolments in IT degrees at Australian universities grew to 36,335 in 2017. The increase in domestic enrolments of 3,965 or 12.3% between 2016 and 2017 marked a significant pick-up in domestic IT enrolments relative to the previous year. It was comprised of a 3,400 rise in undergraduate enrolments and a 570 increase in postgraduate enrolments.

From a longer term perspective, domestic IT enrolments have increased by over 50% since the low of the late 2000s, and in a few years could surpass the 2002 peak associated with the 'dotcom' boom (Chart 2.6). Domestic completions of IT degrees at Australian universities also increased over this period, from 5,502 in 2016 to 5,958 in 2017.

In the VET sector, there was a decline of 11,875 ICT subject enrolments between 2016 and 2017, largely attributable to a fall in ICT subject enrolments at the Diploma or higher level (Chart 2.7). Notably, the decline was driven by a reduction in domestic students' ICT subject enrolments, which fell by 13,400 between 2016 and 2017; in contrast, international students' ICT subject enrolments increased by 1,525 over this period.

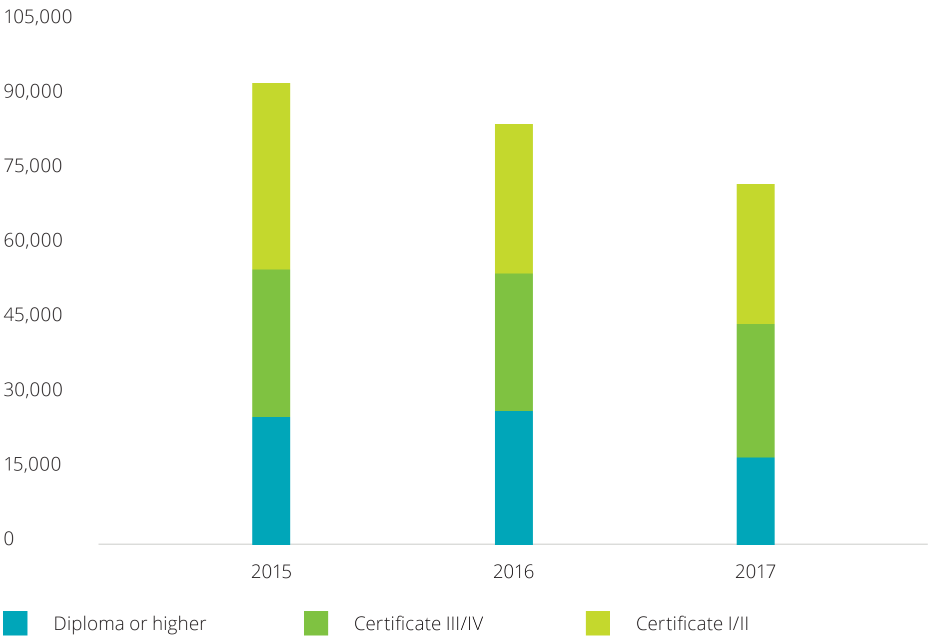
Finally, 2018 saw a systematic change in how overseas technology workers can enter Australia under the skilled migration period. The Department of Home Affairs discontinued the Temporary Work (skilled) visa (subclass 457 visa) in March 2018, replacing it with the new Temporary Skill Shortage visa (subclass 482 visa). Data available since this transition shows that 9,917 temporary skilled visas were granted to technology workers in 2017-18, a substantial decline of 26% or 3,489 from the previous financial year (Chart 2.8). At the same time, the share of total visas granted that was comprised of technology workers remained relatively unchanged at 16%.

Chart 2.6: Domestic enrolments in and completions of IT degrees, 2001 to 2017



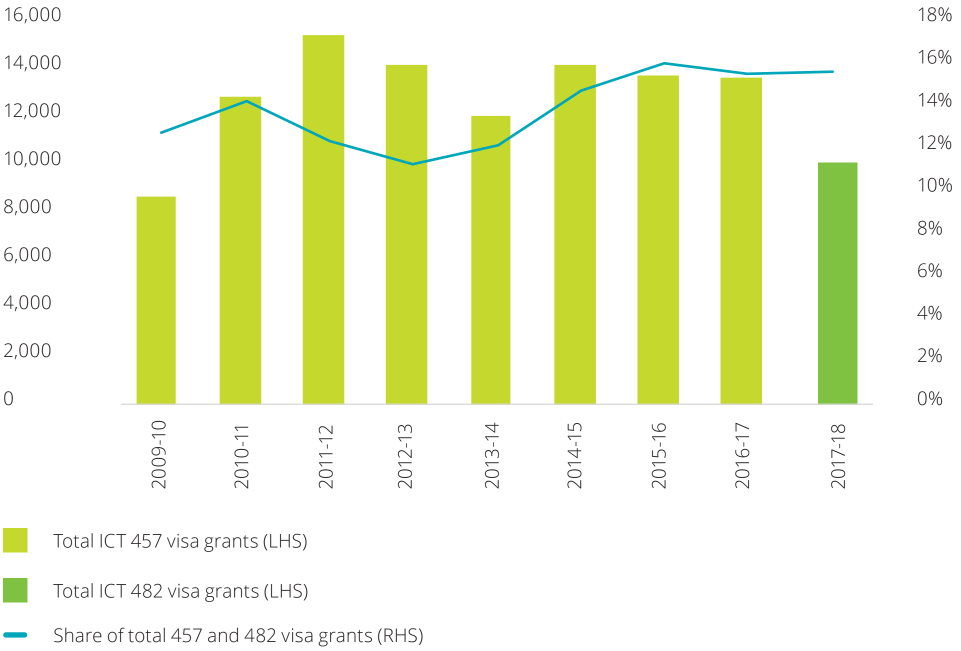
Source: Department of Education U-Cube (2019)

Chart 2.7: Vocational Education Training (VET) ICT subject enrolments by qualification level, 2015-2017



Source: NCVER Total VET Students and Courses 2017 Data Slicer (2018)

Chart 2.8 Subclass 457 (temporary skilled work) and 482 visas granted to technology workers, FY2010-FY2018*



* Excludes ICT industry admin and logistics support, for which breakdowns are unavailable, electronic trades and professional data is for all industries
Source: Department of Home Affairs Temporary Work (Skilled) visa program pivot table (2019)

A supplementary temporary migration program, the Global Talent Scheme pilot, was introduced in July 2018 to attract high-skilled tech workers. There are two main streams – one tailored for established businesses and another for start-ups. However, this pilot program has so far shown few results and may need more time to develop: as of January 2019, there have been zero visa applications lodged or granted for the start-up stream, while the established business stream saw 8 visas lodged and granted (Department of Home Affairs, 2019). The poor uptake has been largely attributed to additional costs, complexities and lack of awareness of the scheme (Pollitt, 2019).

Overall, the supply of technology workers from domestic IT university graduates and temporary skilled migration of technology workers appears to be smaller than the 60,000 increase in the size of Australia's technology workforce observed in 2018. Other sources of technology workers that are likely to have met this demand in the past year include university graduates studying other degrees and permanent migrants.[3] The Australian Government has recently announced that it will reduce Australia's permanent migration intake from 190,000 to 160,000 per year (Murphy, 2019), which may affect future supply of technology workers through this channel.

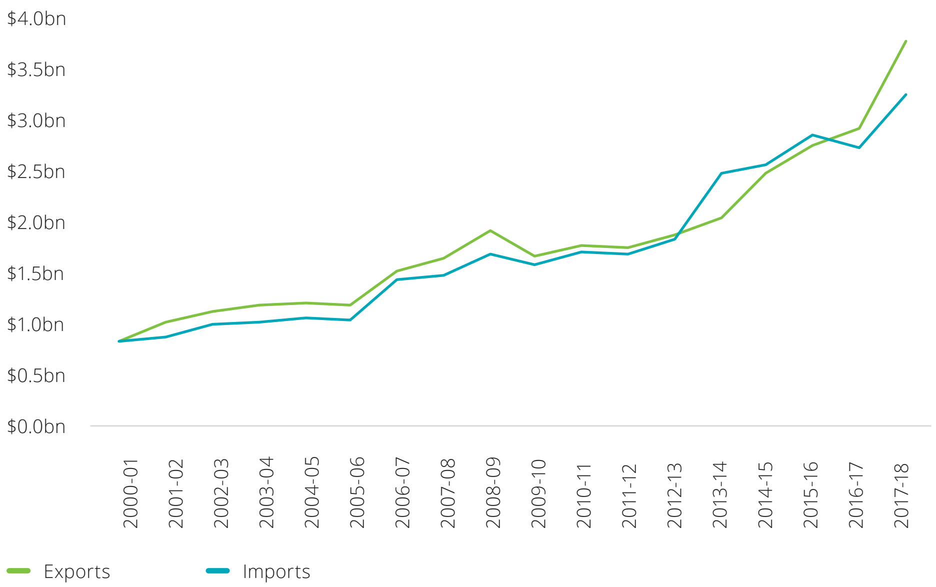
3. Unfortunately, due to changes in the methodology for collecting Overseas Arrivals and Departures data, a detailed occupational breakdown of net migration of technology workers – which includes permanent migrants – is no longer published. The data series that was published between 2012-13 and 2015-16 indicated that net migration of technology workers to Australia totalled around 20,000 workers each year.

2.4 Economic and business activity in digital technologies

ICT exports are a measure of the extent to which a country's production of ICT goods and services are competitive at a global scale and demanded by consumers around the world. Australia's ICT services exports totalled $3.78 billion in 2017-18, a 29% increase from the previous year (Chart 2.9).[4] This has resulted in a continuation of Australia's ICT services trade surplus, which grew to $515 million in 2017-18 from $170 million in the previous year. ICT services imports were $3.27 billion in 2017-18.

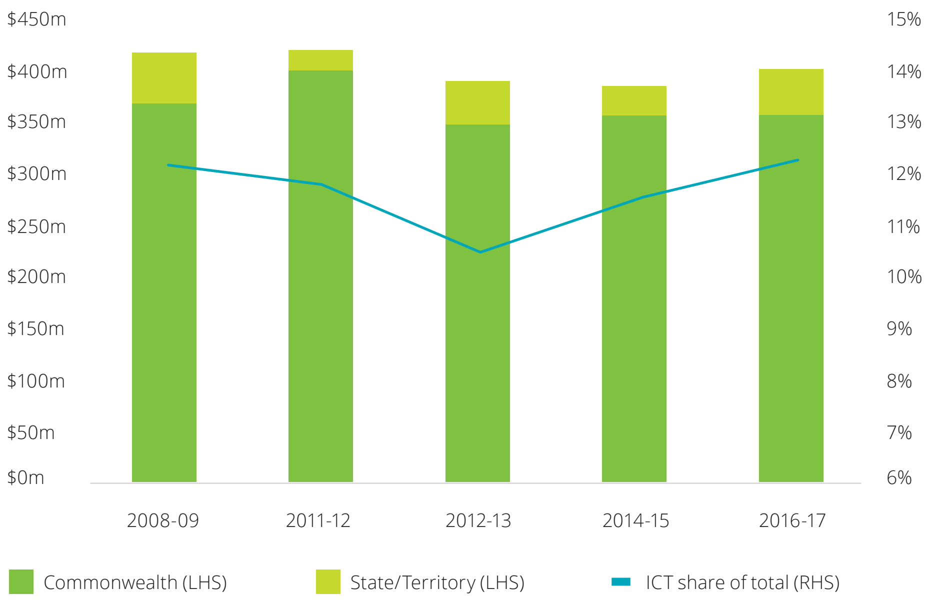
Government expenditure on ICT research and development (R&D) was $402 million in 2016-17, growing by $17 million between 2014-15 and 2016-17, despite a decline in total government R&D expenditure of $50.5 million over this same period. As a result, the ICT share of total government R&D expenditure has increased slightly to 12.3% in 2016-17. While Commonwealth expenditure continues to make up the majority of public ICT R&D spend, the growth observed in the two years to 2016-17 was entirely due to an increase in ICT R&D expenditure by states and territories, (Chart 2.10). Business expenditure on ICT R&D was $6.6 billion in 2015-16, with data on R&D expenditure for 2017-18 yet to be released.

Chart 2.9 Australia's trade in ICT services, FY2001–FY2018



Source: ABS catalogue 5368.0 (2019)

Chart 2.10: Government R&D expenditure, FY2009–FY2017



Source: ABS catalogue 8109.0 (2019)

4. Examining ICT services exports in isolation is likely to understate the importance of digital technology in contributing to a country's international trade, as services exports do not capture the ICT inputs that are embedded in goods exports. For example, the 2017 *Digital Pulse* reported that the ICT input share of Australia's goods exports had increased from 4% in 2013 to 7% in 2016, reflecting the growing uptake of new technologies across economically significant industries in Australia (DAE, 2017).

Furthermore, public investment in emerging technologies such as artificial intelligence (AI) is relatively low in Australia compared to other countries. Although the Australian government has committed $29.9 million over the next four years to fund AI programs, AI funding commitments in Canada and Singapore have totalled $131 million and $151 million respectively between 2017 and 2022 (in equivalent Australian dollars), while government commitments in France and South Korea are $2.4 billion and $2.7 billion respectively over this period (Seo, 2019).

This suggests that Australia could risk falling behind other developed nations in planning for and investing in the digitally driven economic opportunities enabled by emerging technologies such as AI. Indeed, as discussed in Box 2.1 below, recent Deloitte research has found that Australia performs relatively poorly compared to other countries on effectively leveraging AI technologies.

Box 2.1: Australia's relative performance in AI technologies

The second edition of Deloitte's *State of AI in the Enterprise* report examines how businesses across seven countries are using AI technologies such as deep learning, machine learning and natural language processing to pursue a competitive advantage. Although 79% of Australian organisations believe that AI will be important to their business in the next 2 years, they are much less likely than businesses in other countries to be adopting AI technologies in new ways to gain a competitive edge. Half of the AI early adopters in Australia are only using AI to catch up or keep up with their competitors, and a relatively low 22% are using AI to gain a lead over the competition (compared to 55% of early adopters in China and 47% in Germany).

The report finds that AI skills gaps represent a significant impediment to Australian businesses seeking to make the most of new AI opportunities. A third of Australian respondents identified major or extreme AI skills gaps – the highest across the seven surveyed countries – with the largest shortages in AI software developers, researchers and business leaders. Moreover, 41% of Australian respondents reported that their company lacks an overall AI strategy (significantly higher than the international average of 30%). The report notes that more government investment in AI will be required to ensure that Australia can keep up with the levels of public funding for AI initiatives that have been announced in other countries.

Sources: Loucks, Jarvis, Hupfer and Murphy (2019); Deloitte (2018d).

3

Future demand for technology workers and skills

Key findings

2.3%

Australia's technology workforce is **forecast to grow** by 100,000 workers in trend terms between 2018 and 2024, at an average annual growth rate of 2.3% (exceeding overall workforce growth of 1.3% p.a.).

164k

Technology workers will need another 164,000 **qualifications** over this period in trend terms, with 121,000 of these in higher level postgraduate and undergraduate degrees.

7.3%

The largest increase in technology workers is expected in ICT-related industry areas, where demand will increase by over 43,000 by 2024 in trend terms. The **health care industry** is forecast to see the fastest technology workforce growth, at 7.3% per annum and adding more than 9,000 technology workers over this period.

3.1 Increase in technology-related employment and qualifications

The size of Australia's technology workforce is expected to continue to grow in the future, driven by ongoing increases in the uptake of digital technologies across the economy fuelling higher demand for the technology-related skills. In this year's *Digital Pulse*, technology workforce forecasts have been presented in trend terms to minimise the impacts of any year-on-year volatility associated with potential sampling issues in the latest employment data (discussed in Section 2.1).

In trend terms, Deloitte Access Economics forecasts that demand for technology workers will increase by 100,000 workers between 2018 and 2024, representing an average annual growth rate of 2.3% (Table 3.1). This exceeds the forecast growth rate for the overall Australia workforce, expected to be 1.3% per annum over this period.

More than 80% of the forecast increase in the technology workforce is expected to occur in ICT management, operations, technical and professional occupations, continuing the strong growth observed in these groups since 2011 (Chart 3.1). The individual occupations that are forecast to experience the largest increase in workers are software and applications programmers (+17,900 between 2018 and 2024), management and organisation analysts (+12,200) and other information and organisation professionals (+10,600).

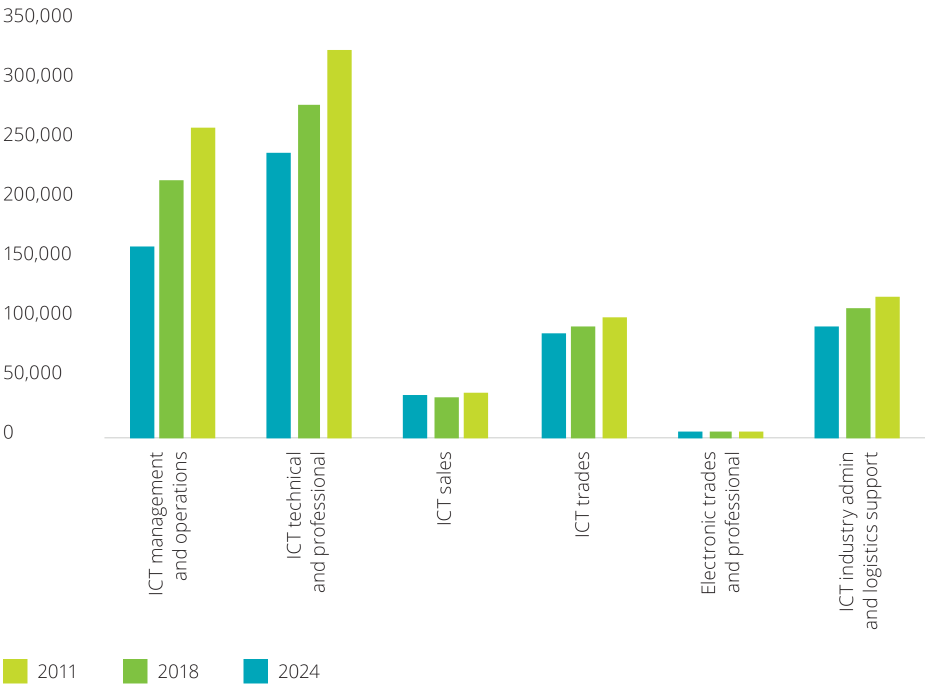
Table 3.1: Trend employment forecasts by CIIER occupation groupings, 2018-24

Occupational grouping	2018	2024	Average annual growth, 2018-24
ICT management and operations	203,817	243,789	3.0%
ICT technical and professional	262,801	305,692	2.6%
ICT sales	31,433	34,325	1.5%
ICT trades	88,005	93,864	1.1%
Electronic trades and professional*	4,011	4,506	2.0%
ICT industry admin and logistics support*	102,240	110,663	1.3%
Total technology workers	**692,307**	**792,839**	**2.3%**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2019)

Chart 3.1: Historical and forecast technology employment in trend terms, 2011-24



Source: Deloitte Access Economics (2019)

There will be higher demand for qualifications held by technology workers over the coming years: consistent with the projected growth in the technology workforce, qualifications demand is forecast to increase at an average of 2.4% per annum in trend terms between 2018 and 2024. The demand for qualifications depends not only on the forecasts for employment growth, but also on other skill and labour market considerations, such as the propensity for different occupations to hold particular types and levels of education. The largest trend growth is forecast for higher level qualifications, with an expected increase of around 76,600 undergraduate degrees and 44,600 postgraduate degrees for the technology workforce between 2018 and 2024 (Table 3.2).

In addition to the core technology workforce who are specialists that develop, operate and maintain ICT systems, there is a broader group of Australian workers who regularly use technology as part of their jobs. As identified in the OECD's framework for measuring the digital workforce (OECD, 2012), this broader measure of employees – such as accountants, solicitors and scientists – rely on technology skills to perform their work and therefore require digital capabilities even though they are not employed in core technology occupations. A full list of occupations included in this broader measure can be found in Table A.4. Deloitte Access Economics forecasts that demand for these workers will increase by around 303,000 between 2018 and 2024 in trend terms, representing an average annual growth rate of 1.8% (Chart 3.2).

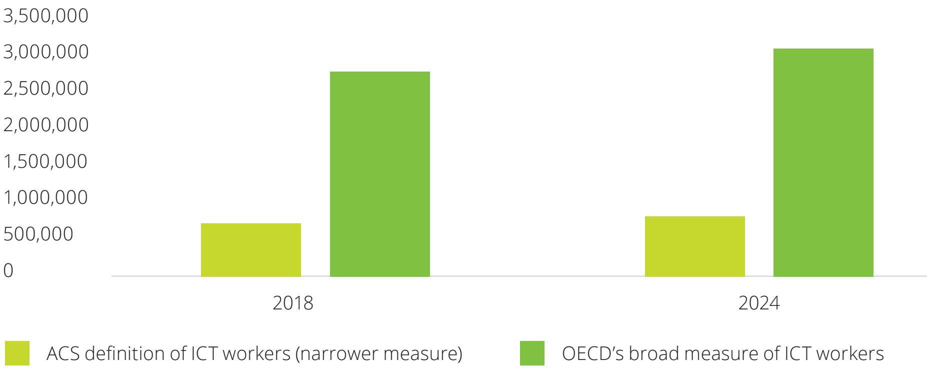
Table 3.2: Trend forecasts of total qualifications held by technology workers, 2018-24*

Occupational grouping	2018	2024	Average annual growth, 2018-24
Postgraduate	217,437	262,016	3.2%
Undergraduate	463,709	540,285	2.6%
Diploma or Advanced Diploma	193,416	219,964	2.2%
Certificate III or IV	140,602	155,604	1.7%
Certificate I or II	65,298	66,530	0.3%
Total	**1,080,463**	**1,244,399**	**2.4%**

* One person may hold multiple qualifications.

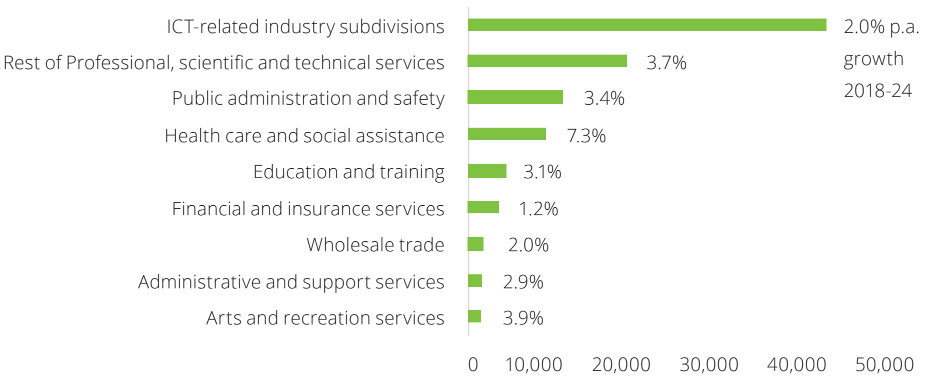
Source: Deloitte Access Economics (2019)

Chart 3.2: Technology workforce growth in trend terms under narrow and broad measures, 2018-24



Source: Deloitte Access Economics (2019)

Chart 3.3: Forecast increase in technology workers by industry, 2018-24



Source: Deloitte Access Economics (2019)

3.2 Forecast demand for technology workers by Australian industries

This year's *Digital Pulse* also breaks down the forecast increase in Australia's technology workforce by industry, in order to understand hot spots of labour market demand in our growing digital economy.

As much of the technology workforce is currently employed in ICT-related industry subdivisions (as described in Chart 2.2), almost half of the projected increase is expected to be in these industry areas, equivalent to around 43,400 additional workers in trend terms between 2018 and 2024. The technology workforce in the rest of the professional services industry is forecast to grow by a further 19,200 workers in trend terms over this period (Chart 3.3).

There are also some industries in the Australian economy that are expected to experience higher-than-average growth in the size of their technology workforces. Most notably, the health industry's technology workforce is forecast to grow at an average annual rate of 7.3% in trend terms between 2018 and 2024, adding 9,400 technology workers over this period. This significant growth is partly driven by the increase in demand for health care services as our population ages and lives longer, and partly related to the increasing digitisation of healthcare procedures and management, as discussed in Box 3.1.

Box 3.1: How digital technologies are improving efficiencies in the healthcare sector

The use of digital technologies is increasing in all sectors and the management and delivery of healthcare services is no different. In response to this growing trend, the Australian Government created the Australian Digital Health Agency (ADHA) in 2016 to improve health outcomes for all Australians through the use of digital healthcare systems. In 2017, after extensive stakeholder consultation, *Australia's National Digital Health Strategy* was published, followed in 2018 by the release of its implementation plan, the *Framework for Action*, which outlines the strategic priorities for developing a world-class digital health system in Australia.

Many parts of the healthcare sector are already increasing their use of digital technologies, recognising the significant benefits, including lower adverse medication events, improved coordination of healthcare for individual patients and increased availability of information for treatment decisions. According to Angela Ryan, Chief Clinical Information Officer and General Manager of Workforce and Strategy at the ADHA, "it is important we understand the needs of clinicians working in the trenches when delivering healthcare services. Technology isn't going to replace staff, but it should help them work more efficiently, for example, a clinician on a ward round using a mobile app to access information to support clinical decisions."

One strategic priority in the Framework for Action is My Health Record, a digital summary of an individual's key health information. Through My Health Record, healthcare providers can access timely information about their patients, such as shared health summaries, discharge summaries, prescription and dispense records, pathology reports and diagnostic imaging reports. The key benefits of My Health Record are reduced adverse drug events, enhanced patient self-management, improved patient outcomes, reduced time gathering patient information and avoided duplication of services. This national digital infrastructure is intended to better connect the Australian healthcare system to realise the benefits discussed above.

The ADHA is also working on related initiatives, such as developing a program for secure messaging (to enable reliable, secure provider-to-provider communication) and improving interoperability between systems in different settings (e.g. hospitals, GPs, aged care providers). This includes through international collaborations, such as the Global Digital Health Partnership which is currently examining important industry and technology issues such as cyber security, interoperability, and clinical and consumer engagement.

To ensure continued growth in Australia's digital health services, Angela says, "we need to provide clinicians with the tools and training required to understand how to interact with technology. Building a digitally-capable health workforce requires updating curricula in universities and the vocational sector so that graduates are equipped with knowledge on areas such as data quality, data integrity, privacy and security mechanisms, and legislative obligations. Consideration also needs to include how we can upskill clinicians who are already on the ground trying to use these technologies."

4

Australia's digital economy: growth and potential

Key findings

$65b

Digital technologies are powering Australia's economic growth – that part which is **powered by mobile technology** will be worth $65 billion to the Australian economy by 2023, as a result of labour and capital productivity improvements.

$10b

There are many benefits from new technologies that will not be captured by traditional measures of productivity and GDP. For example, if we could use **smart city solutions** to keep Australia to a low-congestion scenario between now and 2030, the total benefits due to improved travel times could be almost $10 billion

It will be important to ensure that all Australians benefit from the digital economy.

According to Nobel Prize-winning economist Paul Krugman, this requires widespread adoption of technology across all industries and assisting regions that are negatively affected by digital disruption.

4.1 Australia's growing digital economy and the role of mobile

Mobile technology is a significant part of Australians' everyday lives, with nearly nine out of every ten Australians owning a smartphone (Deloitte, 2017). At the same time, the benefits of mobile technology extend beyond the convenience associated with consumer use of smartphones for communications, entertainment and safety reasons. A significant part of Australia's digital economy is also powered by mobile technology.

The use of mobile drives productivity gains across the Australian economy through a number of different channels, including (Figure 4.1):

- Boosting the **productivity of labour** by allowing workers to easily access information, time savings from using mobile devices to work outside the office and more efficient corporate systems such as mobile-enabled enterprise apps.
- Increase **capital productivity** by enabling teleworking, reducing the need for office equipment and space and improving business communications.

Figure 4.1: Examples of productivity gains from mobile technology

Source: Deloitte Access Economics (2019)

As digital technologies such as mobile devices have become increasingly widespread in their use and benefits across the economy, the motivation and ability to measure the productivity impacts of these technologies has also increased (Weir, 2018). Despite Robert Solow's infamous statement in 1987 that "you can see the computer age everywhere but in the productivity statistics", greater digital uptake in a wide range of industries (including outside of the ICT industry) has enabled us to dimension how computing and other technologies affects overall productivity (Qu, Simes and O'Mahony, 2017).

Deloitte Access Economics has recently estimated the significance of the productivity dividend associated with the use of mobile devices in the Australian economy, finding that by 2023, the contribution to GDP of the digital economy powered by mobile will be $65 billion (DAE, 2019). The growth over the next five years is significant; the contribution of digital to GDP is expected to grow 40% between 2018 and 2023, with new business opportunities continuing to be generated by the roll out of 5G mobile technology later this year.

4.2 Digital economy benefits beyond GDP

It should be noted that the economic benefits of digital technologies to productivity and GDP only provide one perspective on how these technologies have led to improved living standards across the Australian population. There are also a range of other types of welfare gain, such as better access to and quality of health care and education services, as well as non-monetary benefits such as increased choice and lower travel times.

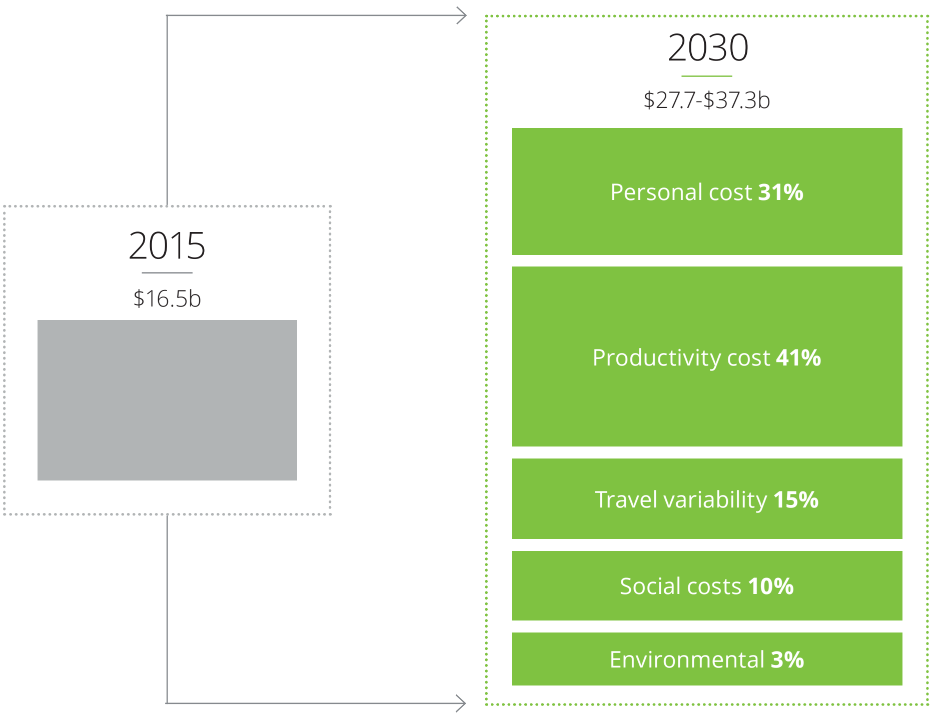
The broader economic benefits of smart city technologies

One example of this can be seen in the issue of traffic congestion in major cities, and how digital solutions such as smart city technologies have provided innovative solutions to easing this congestion, thereby improving both the efficiency of our cities and individual living standards. For instance, by 2025, cities that deploy smart-mobility applications have the potential to cut commuting times by 15 to 20 percent on average (McKinsey Global Institute, 2018).

With Australia's population estimated to hit 30 million by 2030 (ABS, 2018a)—potentially adding 4 million vehicles on the road—congestion issues are likely to become an increasing burden on liveability in Australia's cities. Current congestion levels in Australia, as measured by additional travel time relative to free-flowing traffic, range from 17% in Canberra to 35% in Sydney (BITRE, 2015). This congestion costs the country an estimated $16.5 billion in 2015, the equivalent of 1.3% of Australia's GDP in that year. However, these costs are not captured by GDP as they relate to impacts outside the scope of traditional measurement.

Without major improvements, congestion costs are predicted to increase by 5.5% per year, reaching a cost between $27.7 and $37.3 billion by 2030 (BITRE, 2015). The lower end of this cost range reflects a scenario whereby per capita car use continues to fall, while the upper end is consistent with car use climbing back to pre-financial crisis levels. These costs extend far beyond the direct economic cost of congestion on personal time and at the upper estimates include losses of $15.3 billion in productivity due to congestion, a travel variability cost $5.5 billion, social costs (e.g. cost of blocked traffic interfering with emergency vehicles) of $3.7 billion, and environmental costs of $1.2 billion (Figure 4.2).

Figure 4.2: Cost of congestion in 2015 and forecast cost of congestion in 2030



Source: BITRE (2015)

Figure 4.3: Examples of smart city solutions to congestion

Alternative modes of transport
- Car sharing
- Multi-modal solutions
- Drones

Pathway Optimisation
- Adaptive traffic signals
- SMART corridors

Smart cars
- Autonomous vehicles

Congestion transparency
- Real time traffic feedback
- Pedestrian feedback

In recent years, smart city digital solutions have provided new opportunities to manage congestion and improve liveability for local residents. Smart cities are urban areas that integrate ICT and internet-enabled devices to collect data and use it to optimise operations and services. These technologies offer the potential to reduce congestion by optimising the time required to travel between destinations, increasing the safety of transport and therefore reducing traffic incidents, and minimising environmental impacts.

In a dense city with extensive transit, smart technologies could save the average commuter almost 15 minutes a day. In a developing city with slower commutes, the improvement might be 20 to 30 minutes every day (McKinsey Global Institute, 2018). Smart city technologies provide a variety of solutions through which congestion can be reduced. These opportunities can be classified into four categories (Figure 4.3).

The benefits of each smart city solution for congestion varies. For example:

- Human factors contribute to 95% of road accidents; as such, the introduction of automated vehicles in Australia can significantly reduce road deaths, injuries and associated social costs. Additionally, even a 25% uptake of automated vehicles can reduce journey times by 20% and journey variability by almost 80% (Infrastructure Partnerships Australia, 2017).
- Current use of the adaptive traffic control systems SCATS (Sydney Coordinated Adaptive Traffic System) has been found to deliver savings of 28% in travel time, 25% less stops and a reduction of approximately 15% in the emissions of certain greenhouse gases (Chong-White, Millar and Shaw, 2011).
- Globally, there has been growth in the use of autonomous underground trains, with the International Association of Public Transport reporting that fully automated metro lines surpassed 1,000km in 2018, spanning 63 lines in 42 cities around the world (UITP, 2018). The benefits in cities including Copenhagen, Dubai, Vancouver and Paris have included increased punctuality, reliability and adaptability for planned closures (Railway Technology, 2018).

In addition, greater integration between different modes of transport is required as part of these new solutions to reduce congestion in Australian cities, as this will enable commuters to use a number of public and private transportation options to get from A to B. Such multi-modal transport systems require integration in infrastructure, information and fare payment methods, and these can be facilitated using smart city technologies (Embarq, 2019). Depending on the smart solutions available, it can be logical to leverage the systems that already exist for current transport and operate on the back end. This can increase the efficiency of existing infrastructure while generating overall improvements to transportation flexibility and minimising commuter disruption.

With $27.7 to $37.3 billion at risk by 2030 due to the economic costs of congestion – including productivity, personal, variability, social and environmental costs (discussed above and based on the 2015 BITRE report) – it is imperative that smart city solutions continue to be explored and enacted on. Smart city solutions could be a means to keeping Australia on the low end of this range, which effectively represents economic benefits of almost $10 billion which would not otherwise be captured by GDP.

Finally, it is important to note that the broader economic benefits of smart city technologies extend beyond the benefits of reduced traffic congestion. For example, connected devices and sensor networks across Australian cities have the potential to improve the utilisation of our resources, through technologies that monitor air quality, track electricity and water usage, and optimise the use of energy in real time. Recent research has found that these sustainability benefits could include a reduction in greenhouse gas emissions by 10-15%, a 20-30% decrease in water consumption and a 15-20% reduction in unrecycled solid waste per capita (McKinsey Global Institute, 2018).

What needs to be done to adopt smart city technology in Australia?

Smart city solutions represent new economic opportunities for various levels of Australian governments and stakeholders across the business community. The success of smart city initiatives will be highly dependent on strong engagement from government and business to fostering an ecosystem that is conducive to experimentation and collaboration. Therefore, as depicted in Figure 4.4, it is critical that both the public and private sectors play their part in:

- The planning and development of smart city solutions, and
- The implementation of efficient technological infrastructure.

Figure 4.4: Opportunities for government and business to develop and implement smart city solutions to congestion

	Planning and Development →	Implementation
Business activity	Inform markets	Promote solutions
Combined activity	Develop a strategy	Innovate, collaborate and invest
Government activity	Direct and regulate	Protect and connect technologies

Planning and development

- A strategic plan is critical to successful smart technology initiatives—providing a clear vision and direction for government and business to work towards. Following the development of the 2016 Federal Smart Cities Plan, the number of businesses and communities not yet starting their smart city journey has reduced from 20% in 2017 to 13% in 2018 (O'Keefe, 2019). Of these businesses almost 35% plan to focus on smart infrastructure (roads, bridges etc.)
- Informing stakeholders of existing and/or future smart technologies allows government and consumers to prepare for the technology and identify what supporting services may be required.
- The government can foster innovative ecosystems by directing and regulating markets— ensuring appropriate policies (e.g. open data), laws and regulation are in place to facilitate the development of smart city solutions for congestion. South Australia was the first state to allow on-site road trials of driverless vehicles in Australia in 2016. It is now one of only five CISCO Lighthouse Cities in the world. However, many significant barriers to smart technology still exist. For example, as of 2016, more than 700 potential regulatory barriers to Automated Vehicles had been identified (National Transport Commission, 2016).

Implementation

- Both business and government play a role in innovating, collaborating and investing to ensure that smart city solutions are successful and the impact of smart technologies is as desired. One important form of collaborating is co-investment through, for example, public private partnerships. Between 2000-2009 and 2010-2018, joint transport investment through Public-Private Partnerships increased from 10 to 18 projects. With just 16% of cities able to self-fund required infrastructure projects (Deloitte, 2018b), the importance of joint investments will continue to grow.
- Business can also play the role of promoting the uptake of smart city solutions by clients and consumers. They should support in identifying and promoting new economic opportunities that continue to add value to how Australians experience our cities.
- For government, it is important to protect and connect technologies by securing modern infrastructure and standards to ensure trust in new technologies. The challenge lies in understanding the requirements of future technologies, ensuring enough specialised expertise in and resources for technological infrastructure and increasingly understanding how to work with third parties to securely deliver critical capabilities (Coden and Bartol, 2017).

Action plan

Based on this analysis, a potential action plan for governments in Australia seeking to use smart city technologies to reduce congestion and increase living standards could include the following steps:

1. **Minimising regulatory compliance burdens** by developing 'standards roadmaps' to safeguard the interoperability of smart city technologies.
2. Providing funding and technical **support at the local level**, such as Federal and/or State Government support to address smart city barriers faced by Local Governments. This could build on the Federal Government's stated intention to use City Deals between the three levels of government to deliver its Smart Cities Plan (DIRDC, 2019).[5]
3. Improving the **flexibility and transparency of public-private partnerships** as a funding source for smart city infrastructure investments.
4. **Investing in core smart city infrastructure,** including:
   a. *Connectivity infrastructure* such as affordable, low bandwidth wireless networks to ensure new devices and technologies can communicate with each other
   b. *Feedback infrastructure* such as sensor technology so that real-time city data can be collected
   c. *Data platform infrastructure* which enables businesses, government and the public to openly access and use the collected data.
5. **Integration with existing systems,** leveraging existing transportation networks such as multi-modal options.

5. City Deals have been agreed or announced in Townsville, Launceston, Western Sydney, Darwin, Hobart, Geelong, Adelaide, Perth and South East Queensland. Examples of smart city initiatives that have been included as part of these City Deals include investments in smart parking activities in Geelong and the launch of the Smart Townsville strategy (DIRDC, 2019).

4.3 Ensuring all Australians benefit in the digital economy

In an increasingly digitised economy and society, it is important that the welfare gains arising from greater use of technology can be realised across the Australian population. A recent interview with renowned economist Paul Krugman (discussed in Box 4.1) highlighted several important conditions for ensuring that both the productivity growth and broader non-GDP benefits of digital disruption can be maximised and experienced across the Australian economy:

- Implementing technology solutions across all industries, so that the economic gains from digital advancement can be attained through a wide range of sectors and applications.
- Assisting workers and regions that are negatively affected by digital disruption trends to transition towards new industries and careers, so that no one is left behind.
- The importance of local education and training institutions as incubators for new digital ideas and growth in local tech companies.

Box 4.1: "It's not Silicon Valley, it's what Walmart is doing with the new technology from Silicon Valley" – Paul Krugman

The way in which digital technology has driven economic change and affected the labour market across industries is widely recognised. According to Nobel Prize-winning economist Professor Paul Krugman, "it's not about what happens in Silicon Valley, it's about what Walmart is doing with the new technology from Silicon Valley". But this experience is nothing new: as early as the 19th century, economist David Ricardo observed that machinery advancement was disrupting industries across the economy, in a similar manner to how digital technology has disrupted industries today. Professor Krugman stresses that growth deriving from digital advancement is not solely due to technology firms themselves, but how companies across industries incorporate new technologies to increase productivity.

Other examples of these digitally driven productivity improvements include logistical and administrative efficiency gains from tasks that were previously repetitive and time consuming. As jobs with such functions become redundant, Professor Krugman notes that personal services such as healthcare and social assistance will take up a larger share of total jobs in the future, stating that "the US Department of Labor forecasts show the top ten employment growth areas are in personal service fields like nursing".

While Professor Krugman was clear that digital technology is one of the bedrocks for economic growth, he advises policymakers to be proactive in addressing some of the transition pains experienced by workers due to these disruptions. "Technological change is an old story; what's new is the failure to share fruits of that technological change. It's not just people, but entire regions [of the US] are being left behind." He attributes this to the declining bargaining power of workers, and growing skills gaps in the labour market.

To remedy this, Professor Krugman suggests that policymakers should focus on keeping unemployment low economy-wide, maintaining social safety nets and better matching training to skill shortages: "reskilling should be the responsibility of all of us". Moreover, there can be shortages of tech talent in metropolitan areas, with Professor Krugman outlining an example of Amazon potentially needing to bring in new workers should they wish to open a new facility in New York, given the already low unemployment rate there. Investment and digital reskilling in regions that have been disrupted by technological change could provide an opportunity to access more of the workforce and develop new digital hubs in regional areas.

In February 2019, Australian Computer Society CEO Andrew Johnson hosted a fireside Q&A with Professor Paul Krugman on economic and jobs growth in an era of digital disruption. Professor Krugman received the 2008 Nobel Prize for Economics for his work on international trade and economic geography, and is a distinguished scholar at the Graduate Centre of the City University of New York as well as a frequent New York Times columnist.

5

Policy implications

Key findings

Three policy priorities for driving the growth of Australia's digital economy are boosting skills, start-ups and investment.

$11,000

The **benefit from reskilling workers** to meet employer demand for digital skills could potentially be more than $11,000 per worker per year. Flexibility, foundations and funding are the three aspects of government policy required to enable this reskilling.

1,700

Although there are more than 1,700 **start-ups in Australia** and total venture capital investment of $11 billion in 2018, Australia is relatively 'middle of the pack' when it comes to enablers, barriers and market conditions for start-up success.

18.5% vs. **38.6%**

Australia's tax landscape for digital investment appears to be less favourable than other developed countries, with an effective return of 18.5% for **investments in early-stage tech companies** (compared to 38.6% in the UK), and an effective tax rate of 13% for companies investing in R&D (compared to 0% in Canada).

5.1 Reskilling and training for future needs

The reskilling imperative for meeting digital skills demand

This year's *Digital Pulse* highlights that Australia will need an additional 100,000 technology workers to meet employer demand by 2024. New entrants to the workforce, such as university graduates and skilled migrants, will be part of the supply solution for meeting these demands for digital skills. However, as discussed in Section 2.3, the number of temporary skilled visas granted to technology workers in the most recent 2017-18 financial year declined significantly, suggesting that reliance on skilled migration as a source of technology-related skills is unlikely to be sufficient or sustainable.

There are some positive signs in the continued growth of IT university graduates, with total domestic completions of information technology degrees rising to almost 6,000 in 2017, along with a substantial increase in domestic enrolments (to just over 36,000 in 2017). However, the completion rate of domestic IT graduates remains lower than it is for other fields of study, with an enrolment-to-completion ratio of 15% for IT undergraduates (compared to 18% in other fields) and 24% for IT postgraduates (compared to 32% in other fields) (Department of Education and Training, 2019).

Moreover, there is likely to be some lead time before a larger pipeline of university graduates is able to benefit overall technology worker supply. In particular, although Australian employers are generally satisfied with the quality of university graduates with undergraduate computing and information systems qualifications (reporting 87% satisfaction in 2018), they were more likely to be satisfied with IT graduates' technical skills than their employability skills – such as the ability to perform and innovate in the workplace (QILT, 2019). As these latter skills are in high demand amongst employers of technology workers, new graduates may need time and experience to develop employability skills before joining the technology workforce.

Reskilling existing Australian workers in the required digital skills will therefore be required to meet growing employer demand. Investment in reskilling will not only enable immediate skills shortages to be met, but will also ensure that Australia has the digital talent required to seize new opportunities created by the fourth industrial revolution and upcoming waves of digital disruption.

Moreover, as highlighted by Paul Krugman in Box 4.1, it is the incorporation of digital technologies across a range of industries beyond technology businesses themselves that will generate economy-wide increases in productivity and growth. To successfully implement emerging technologies in these industries, workers will need both industry specialisation and technical ICT skills. Reskilling existing workers in these industries will enable them to combine specialist technical knowledge with the digital skills required, facilitating innovation and efficiency gains as new technologies are integrated into existing operations and roles. Box 5.1 highlights an example of how Australia's mining sector is approaching the skills challenges associated with the increasing digitisation of mining operations.

Box 5.1: Education and training to meet future mining skills needs

The mining sector is rapidly evolving as major technological improvements such as robotic process automation, artificial intelligence and big data analytics drive changes in processes and activities across the mining value chain. According to Sid Marris, who advises the Minerals Council of Australia's (MCA) on its 'Future of Work' agenda, "mining companies are adopting cutting-edge technology at a rapid rate, and the shift towards the 'digital mine' is creating changes in what skillsets will be required and flow-on effects for providers of mining education".

Research commissioned by the MCA to examine what future skillsets will be required in the 'digital mine' reveals that technical skills such as data analytics and visualisation, operations analysis, and systems evaluation will be in high demand. Broader enterprise skills such as judgement and decision-making, collaboration and design-thinking will also be essential, with Sid noting that "the mining engineer of the future will increasingly need to work in collaborative teams with metallurgists, electricians and other professions, so these 'soft skills' are important".

It is essential that education providers work with industry to ensure that the skills and knowledge developed can meet mining's future needs. The MCA and many mining companies engage with universities as part of course and curriculum design. For example, the Mining Education Australia (MEA) collaboration between University of New South Wales, University of Adelaide, University of Queensland and Curtin University has a common national curriculum for third and fourth-year mining engineering students, which integrates industry, academic and learning resources. This ensures consistency and equips students with the necessary skills demanded by mining employers, and the MEA delivers more than 85% of Australia's graduates from mining engineering courses (UNSW, 2019). MEA is now reviewing its programs to ensure they meet emerging needs.

There is an increasing role for mining companies to identify their skills needs and support their workers in developing these required skills. This includes collaborating with education and training providers to create learning opportunities with suitable content and formats. According to Sid, "micro-credentialing is being examined as a way to build specific skills that are seeing increasing demand across the industry due to increased use of digital technology on mine sites". For example, Rio Tinto has partnered with the WA Government and South Metropolitan TAFE to deliver new qualifications in automation, enabling workers to supplement their mining knowledge with the technology skills required to work as an automation programmer or system technician either in a remote operations centre or monitoring technology on mine sites (Rio Tinto, 2018).

Policy initiatives to encourage digital reskilling

While the technology skills shortages identified in this report may be naturally addressed by industry, workers, education providers over time, it may take too long. This would mean lost opportunities for the Australian economy. In this context, there could be a role for government to invest to ensure we capture these growth and innovation opportunities, while potentially also bringing forward some of the public (and private) benefits.

There are three areas that government policy can target to encourage more digital reskilling across the Australian workforce: flexibility, foundations and funding (Figure 5.1).

Flexible learning options are required if the government and industry are going to entice Australian workers to enter digital reskilling training opportunities. For example, previous research has found that 78% of workers interested in study want at least half of their learning delivered online, and almost half have a preference for 'bite-size' intensive learning opportunities (Deloitte, 2018a). At the same time, it is essential that the training delivered enables workers to develop competencies in, and eventually mastery of, the required digital skills – to ensure that the skills developed through this investment in training meet the needs of employers in the economy.

One example of a program developing technology skills that balances both flexibility in education format and mastery-based learning is Launch School. The organisation delivers coding education and training that enables students to develop the skills required to become a software engineer. Its focus on mastery-based learning means that students only progress through the curriculum once they have fully developed the required capabilities and knowledge, rather than a time-based approach to the length of training (Launch School, 2019). This also allows for a flexible delivery format, as students can progress through the training materials at their own pace while ensuring they develop the fundamental technical technology skills required to either work as a software engineer or utilise new technologies in their current industries and roles.

Figure 5.1: Policy initiatives for digital reskilling

Source: Deloitte Access Economics

Greater recognition of these more flexible learning programs as formal credentials could increase workers' awareness of the available reskilling options, as well as potentially improving the portability of learning outcomes across different roles and industries. The government has a role to play in ensuring that the regulation around formal qualifications and credentials keeps up with newer education products that develop technology skills in the training market. The Review of the Australian Qualifications Framework (AQF), which is currently underway, is specifically examining how the AQF can recognise new skills and learning methods (AQF Review, 2018).

The right **foundations** need to be in place to enable effective implementation of digital reskilling options. As discussed in Box 5.2, this includes ensuring that Australian workers have suitable foundational numeracy and literacy skills before they can develop the more advanced technology skills to succeed in an increasingly digital economy, as well as restoring accountability for education and training providers to deliver high quality employment outcomes.

In the 2019-20 Budget, the Government committed $62.4 million over four years from 2019-20 to provide more learning opportunities for at-risk workers to develop their foundational literacy, numeracy and digital skills (as part of the Skills Package, discussed below). This follows the recommendations in the final report of the *Strengthening Skills: Expert Review of Australia's Vocational Education and Training System*. The report warned of the risk of a "skills mismatch of a significant scale" arising from accelerated digital disruption in the economy, as successful participation in the future workforce will require a well-developed foundation of language, literacy, numeracy and digital skills (Joyce, 2019). It remains to be seen how these foundational learning programs will be implemented in practice.

Box 5.2: Foundations required to enable successful digital reskilling

Training Australian workers to develop the necessary technology skills will be an important driver of growth as various industries across the economy become more digitised. In such an environment, many workers will need to be able to understand and implement technology solutions to improve their productivity and succeed in the new jobs created by digital disruption. However, the right foundations need to be in place to ensure that workers can effectively take up digital skills development opportunities. As highlighted by Elena Douglas, Chief Executive Officer of the innovation and strategic consulting firm Knowledge Society, "these foundations include improving workers' basic numeracy and literacy skills, and restoring the chain of accountability in Australia's universities and TAFEs".

While Elena views mastery-based learning approaches such as Launch School (discussed earlier) as the best practice in delivering ICT education and training, she notes that "addressing the widespread numeracy and literacy problems across the workforce is necessary before these workers can train in more advanced digital skills. Good training in mathematics requires planning and logic, and is itself a logical approach to problem solving. The decline of the study of maths overall in Australian high schools must be addressed in order to provide the right pipeline of future workers for ICT and industry". A recent report by the OECD highlighted that more than 20% of Australian adults have very low literacy and numeracy skills – at most being able to read brief texts or understand basic percentages – and that low-skilled individuals are least likely to engage in ongoing adults learning (OECD, 2019). Improving these foundational skills is a prerequisite to enabling these individuals to subsequently take up opportunities for digital skills development, otherwise there is the risk that the gap in the capabilities and labour market outcomes of highly-skilled and low-skilled workers will widen in the future.

Another foundational issue that Elena raises as essential is the need to restore accountability amongst universities and TAFEs in delivering high quality employment outcomes: "for example, this could include a role for government in providing information on performance or ratings for individual education and training institutions, and pathways from education to employment outcomes". This is necessary so that workers can make informed decisions about what digital reskilling opportunities could be most usefully applied to their career aspirations and skills development objectives. In addition to the government's role in facilitating this accountability, there may also be potential roles for professional associations, employers and individuals themselves to hold institutions accountable for delivering relevant employment outcomes.

Funding for digital reskilling opportunities could be provided by governments to various stakeholders in the Australian labour market and training ecosystem – including individual workers, employers and education providers. In deciding how to allocate funding to encourage the provision and take-up of technology-related training, governments must consider what initiatives would have the lowest relative cost and the largest relative public (and private) benefits.

An example of a learner-driven approach to funding digital reskilling in the workforce is the 'SkillsFuture Credit' scheme introduced in Singapore in 2016. It provides all adults aged 25 years and over with a credit of SG$500 (plus periodic government top-ups), which can be used for approved education and training courses – which include courses in areas such as digital transformation, data analytics and software development (SkillsFuture, 2019). In its first two years, more than 285,000 working adult Singaporeans have undertaken training under the scheme, with "infocomm technology" courses seeing relatively popular take-up (Sim, 2018). However, there may be challenges in scaling up the population-wide reskilling measures that have been introduced in Singapore, given the relatively small size of the workforce there.

Providing funding to employers to make technology education and training decisions is another option – such as in Korea, where small and medium-sized employers are paid subsidies to provide skills development programs to their workers, including training in digital skills (OECD, 2016). Collaboration with education providers to design and deliver training that is relevant for industry needs is encouraged through 'training consortiums' of large companies, small businesses, industry associations, universities and other training providers. For example, the Advanced Technology Education Center – a partnership between a university and various technology companies – has provided digital skills training to more than 6,000 small businesses and over 41,000 workers, with based on investigations into the skills demanded by industry (Lee, 2016).

In the 2019-20 Budget, the Government announced a Skills Package which included $525 million in funding over five years to begin to address the future skills needs of the Australian economy. In addition to the foundational learning commitments discussed above, the Skills Package included the establishment of a National Skills Commission to enhance Australia's approach to skills development in areas of future job growth, and a trial of national training hubs in regions with high youth unemployment to improve linkages between schools and local industry. (Note that some of the funding in the Skills Package also relates to training in areas outside of technology, such as support for apprenticeships and developing trade skills.) In the lead-up to the May 2019 Federal Election, the Labor Party announced that it would fund 5,000 free TAFE places for ICT and digital skills courses, as part of the 100,000 overall TAFE places it had committed to funding (Housego, 2019).

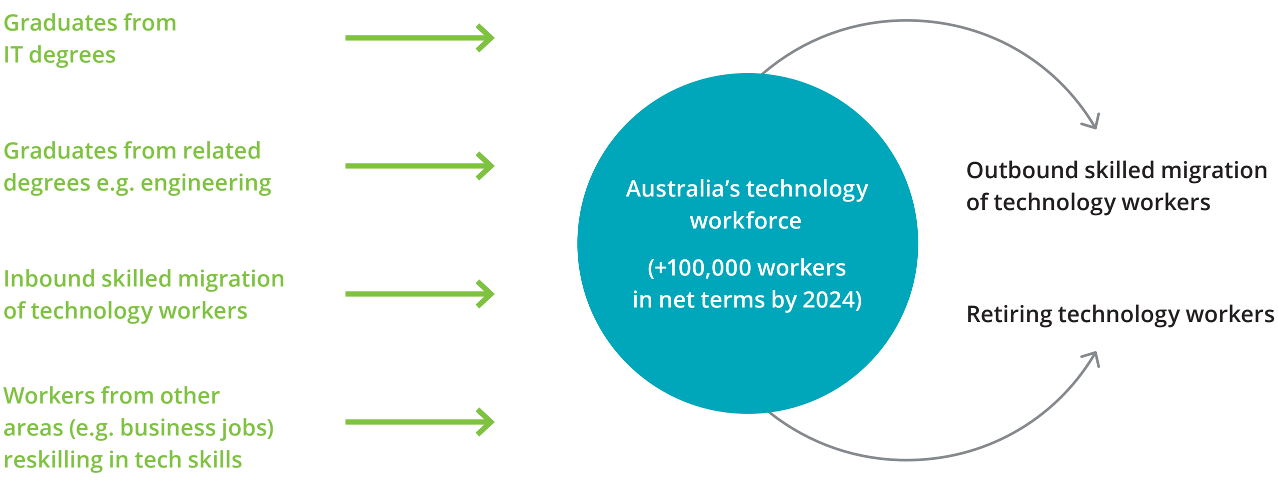
Finally, while Australian governments can implement policy settings that support reskilling in technology-related capabilities, it is ultimately up to all stakeholders – including employers, individuals, educational institutions and labour unions – to collaborate to ensure that our workforce can develop the talent necessary for driving future growth in the digital economy. Businesses and education providers will need to work with each other to identify the skills needs of the future, and to design and implement the training solutions required to enable workers to reskill in these areas. In this context, governments will need to learn rapidly from each other and other stakeholders in the digital ecosystem to uncover the most effective approaches for developing the required technology skills.

Potential benefits of digital reskilling

This year's *Digital Pulse* has found that Australia will need 100,000 more technology workers by 2024. While some of these workers will come from new university graduates and skilled migrants, supply in the technology workforce will also need to be supported by the reskilling of existing workers. Figure 5.2 illustrates the various pathways that Australia will need to rely on to ensure that our technology workforce will have sufficient supply of digital workers to meet employers' current and future needs.

Based on the most recent data on domestic IT university graduates and technology-related skilled migration visas, almost 45,000 of the forecast increase in demand for technology workers by 2024 may need to come from reskilling workers that are currently in other occupations.[6] However, there are a range of factors that will determine the actual amount of reskilling required. For example, as the 100,000 additional technology workers is a net forecast of employment growth (i.e. replacing retired workers would be on top of this), the 45,000 estimate of reskilling requirements could be an underestimate. On the other hand, technology workers may be sourced from graduates of other university degrees (e.g. engineering), which would lower the reskilling requirement. The development of a national technology workforce plan that examines graduates, skilled migration and reskilling needs in greater detail would be useful for informing the assessment of future digital training needs.

Figure 5.2: Pathways into Australia's technology workforce



Source: Deloitte Access Economics

6. The estimate that 45,000 technology workers will need to come from reskilling is based on the assumptions that of the 100,000 additional technology workers required in the six years to 2024:
(i) demand for around 36,000 may be met by the supply of new IT university graduates (6,000 each year)
(ii) a further 20,000 may be filled by technology worker skilled migration (assuming the 10,000 technology workers that are granted 482 visas each year stay for 2 years, the maximum length of the short-term visa stream).

One example of estimating the benefits of digital reskilling is using wages as a proxy for the marginal product of labour in the economy, and examining the wage differential for workers undertaking digital reskilling. Earlier editions of the *Digital Pulse* have found that around one in four technology workers had a previous job that was a non-technology role, and the most commonly studied degrees amongst technology workers are business areas such as management, marketing and accounting (DAE, 2018). This suggests that the wages of workers in other professional industries, including business-related fields, could be a relevant comparison point to technology worker wages. Under this approach, the average benefit is estimated to be around $11,100 per year – the difference between the average annual wage earned by technology workers (around $100,700 in 2018) and workers employed in professional industries ($89,600).

The financial costs associated with digital reskilling may be less modest than one might assume. For example, enrolling in the mastery-based coding learning program Launch School costs US$199 per month. A 1-year enrolment in the Launch School program would therefore only cost around $3,300 per person (using an AUD/USD exchange rate of 0.71). However, individuals will need to invest their own time, and there may be other non-financial barriers preventing some workers from making the transition even if they are funded to undertake digital reskilling training, such as risks and uncertainties associated with career transitions. Notwithstanding these uncertainties, the example of benefits discussed above suggests that there could be big potential gains from reskilling workers to meet the expected shortfall in technology skills – and, as discussed above, we know from the current stock of technology workers that some people are already doing this.

5.2 Australia's start-up landscape and policy implications

Central to Australia's economic growth and increasing living standards is sustained growth in productivity (The Australian Government, 2016), and one of the core drivers of productivity is the development of new and innovative technologies.

Within the broader digital ecosystem, Australia's start-up community is a contributor to the development of such technologies. A start-up is a company that delivers a new product or service, or delivers existing products or services in a new way. Start-ups can therefore form in any industry by, for example, providing food delivery services, new retail shopping experiences, personalised health care and enabling new construction techniques.

One important group of start-ups are tech start-ups: companies that are delivering new technologies to both Australia and the world. Highly successful companies that began as tech start-ups in Australia include Canva, Afterpay and Airtasker, which now have a combined value of over $5 billion (StartupAUS, 2018).

The tech start-up landscape in Australia

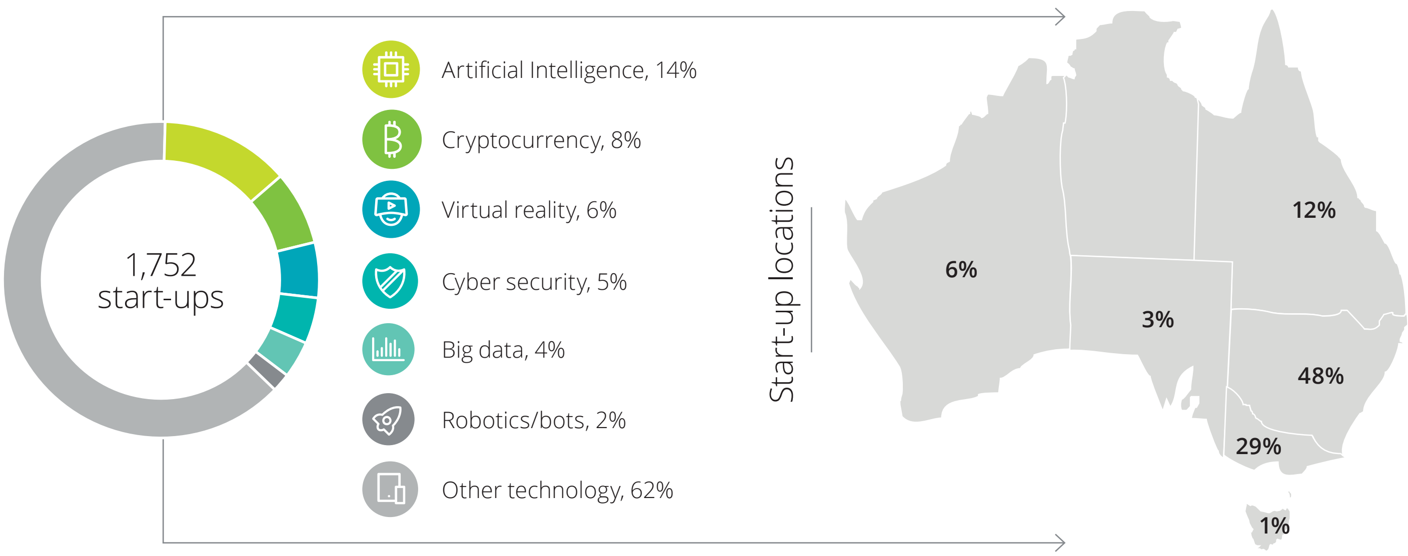
There are an estimated 1,752 start-ups in Australia developing a large variety of technologies, based on an analysis conducted by Upwise in early 2019 on companies founded since 2014, on behalf of the Australian Computer Society.[7] These start-ups are largely concentrated in major cities, and are most prevalent in New South Wales, followed by Victoria and Queensland (Figure 5.3).

Start-ups vary by the type of technology they are developing and the industry in which they work. A significant number of start-ups in Australia are working in artificial intelligence (14%), cryptocurrency related activities (8%) and virtual reality (6%). However, the majority of start-ups (62%) are developing unique technological products and services outside of these main areas of technological focus. Additionally, while the tech focus means that a large proportion of these start-ups are concentrated in the ICT industry, they also span other industries including finance (Fintech), biomedicine (Biotech) and education (Edtech).

The nature and extent to which tech start-ups operate in ICT, as compared to other industries, can be identified by taking an in-depth look into venture capital (VC) investment and innovation levels in each industry. Sourcing the right levels of investment to fund increased scale and commercial growth is often an important condition for start-up success: it has been estimated that 97% of start-ups will either exit or fail to commercialise and scale (McLeod, 2017). This often occurs during the high-risk period between initial funding and commercialisation where companies find it difficult to attract investment.

Chart 5.1 presents the volume (number of deals) and intensity (average size of deals) of VC investment in Australia, overlayed by the relative level of new goods and services innovation occurring within each industry.[8] The total amount of venture capital and later stage private equity funding raised in Australia in 2018 was $11 billion (ABS, 2018b).

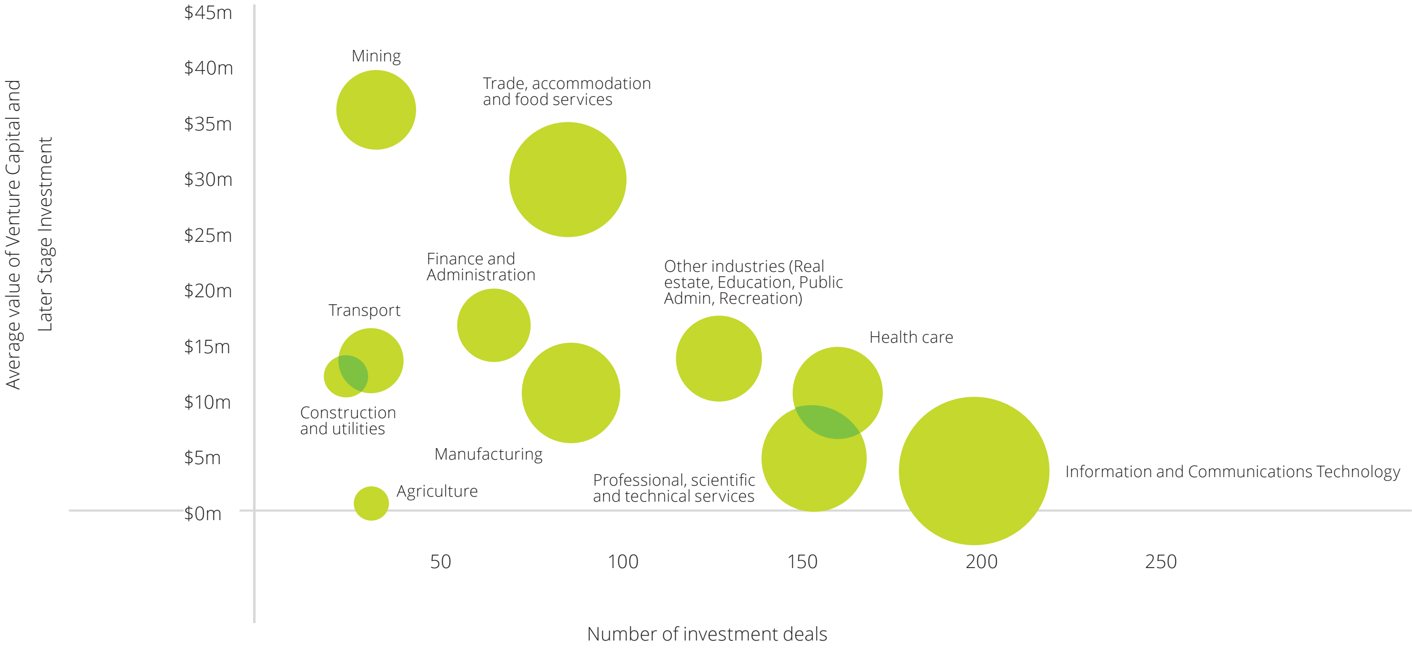
Figure 5.3: Overview of Australia's tech start-up landscape



Source: Upwise (2019)

7. Upwise identify start-ups as: a company founded in Australia that is active and operating, has more than one employee, has developed an innovative product or technology-related service, and was founded since 2014.
8. As measured by venture capital and later stage private equity investments in Australia (ABS, 2018b).

Chart 5.1: Venture capital market activity by industry in 2018, by level of innovation (size of bubbles)



Sources: Deloitte Access Economics analysis of ABS (2017, 2018b) data
Notes: Innovation is determined by the relative proportion of small businesses (employees <20) who developed new or significantly improved goods or services (FY16).

There is an inverse relationship between the volume and value of VC investment across industries in Australia. ICT is the largest sector in terms of the number of VC deals and has a relatively high rate of innovation, but receives one of the lowest levels of investment per deal. Health care and professional services are the next most active sectors by volume, and also experience relatively smaller levels of investment per deal. Higher volume, lower value investments can reflect high levels of competition for investment in these industries, and/or relatively lower costs for developing innovative products and services.

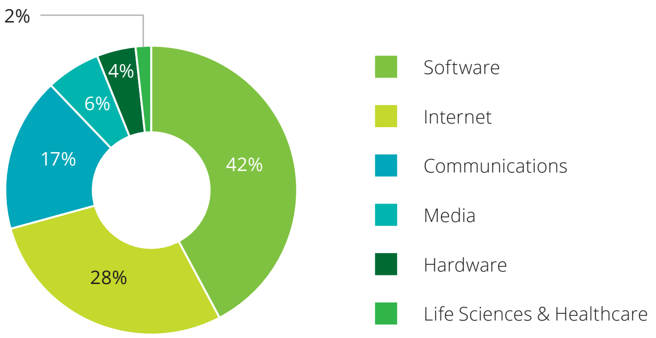
Conversely, the mining industry has one of the lowest volume of VC activity, but the highest level of investment per deal. As above, this could reflect low levels of competition (e.g. a small number of competitor mining businesses) and/or high costs of development and delivery due to complex technology requirements in the industry (Matysek and Fisher, 2016).

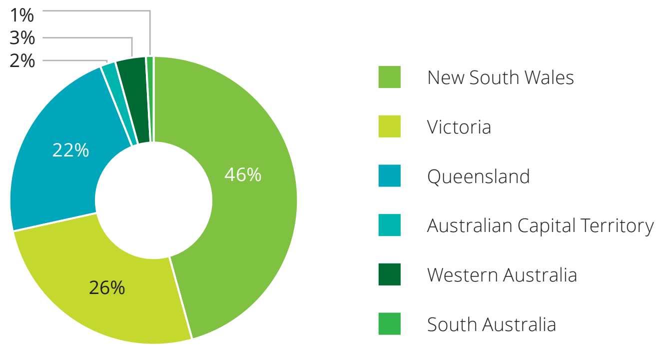
Operations and financing of high-performing tech start-ups

Each year, Deloitte determines the top 50 fastest growing tech start-ups in Australia in the *Technology Fast 50* report (Deloitte, 2018c). A sample of over 100 short-listed firms from the 2017 report has been analysed to examine the operations, funding and maturity of these top performing tech start-ups in Australia.

The majority of high growth tech start-ups considered for the *TF50* report are located in NSW (46%), Victoria (26%) and Queensland (22%). A large proportion of these start-ups are developing software, internet and communication technologies (Chart 5.2).

Chart 5.2: Distribution of high-performing Australian tech start-ups in 2017, by company type and location





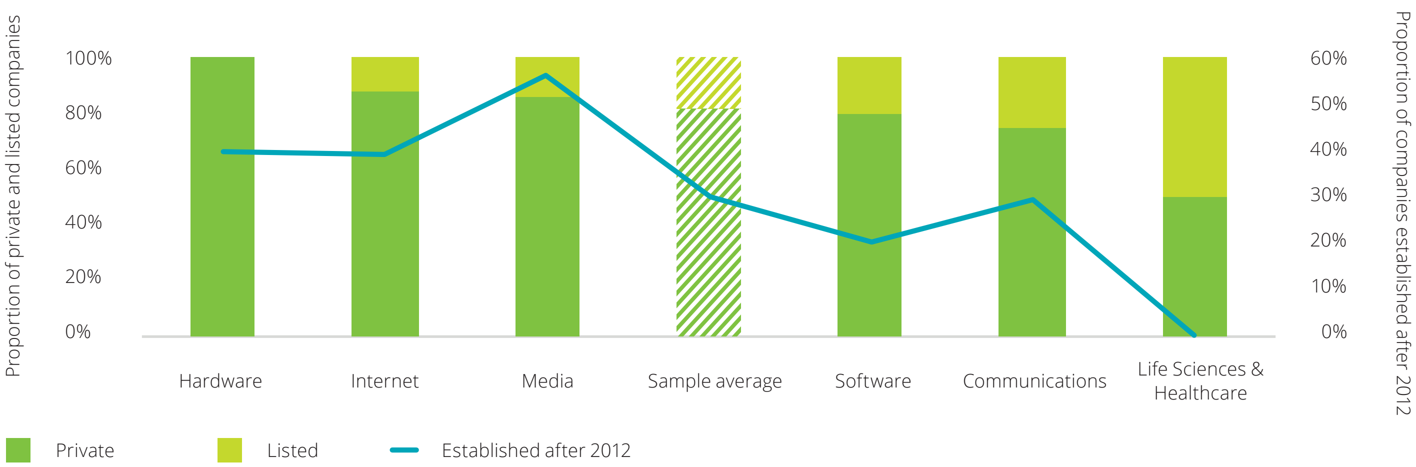
Source: Deloitte Tech Fast 50 data (2017)

In total, 82% of companies in the sample are privately held. This largely reflects the fact that listed firms are typically more mature and larger than privately held companies:

- 89% of firms established after 2012 are private, compared to 79% prior to 2012.
- The average revenue for private tech start-ups is $17m in 2017, compared to $104m for listed start-ups.
- Revenue growth for private companies is two-thirds that of listed companies (487% compared to 640%).

Different company types also have varying business models. This is partially, but not entirely, related to the maturity of the business (as discussed above). For example, there is a higher proportion of listed companies amongst communications start-ups than software start-ups, despite communications having a higher proportion of younger businesses.

Chart 5.3: Distribution of private and listed high-performing tech start-ups, by company type



Source: Deloitte Tech Fast 50 data (2017)
Note: Small sample sizes in Life Sciences and Healthcare (2), Hardware (5) and Media (7)

Start-up enablers and barriers: an overseas comparison

In an increasingly global, technologically focused market, the ability for Australia to encourage and maintain innovative start-ups depends on the competitive landscape in which these businesses operate. A comparison of high-performing start-up environments overseas provides insight into the factors that help or hinder a start-up's success and the areas in which Australia's start-up landscape can be improved. Two areas are compared:

- Direct enablers and barriers to start-up activity
- Market conditions for success.

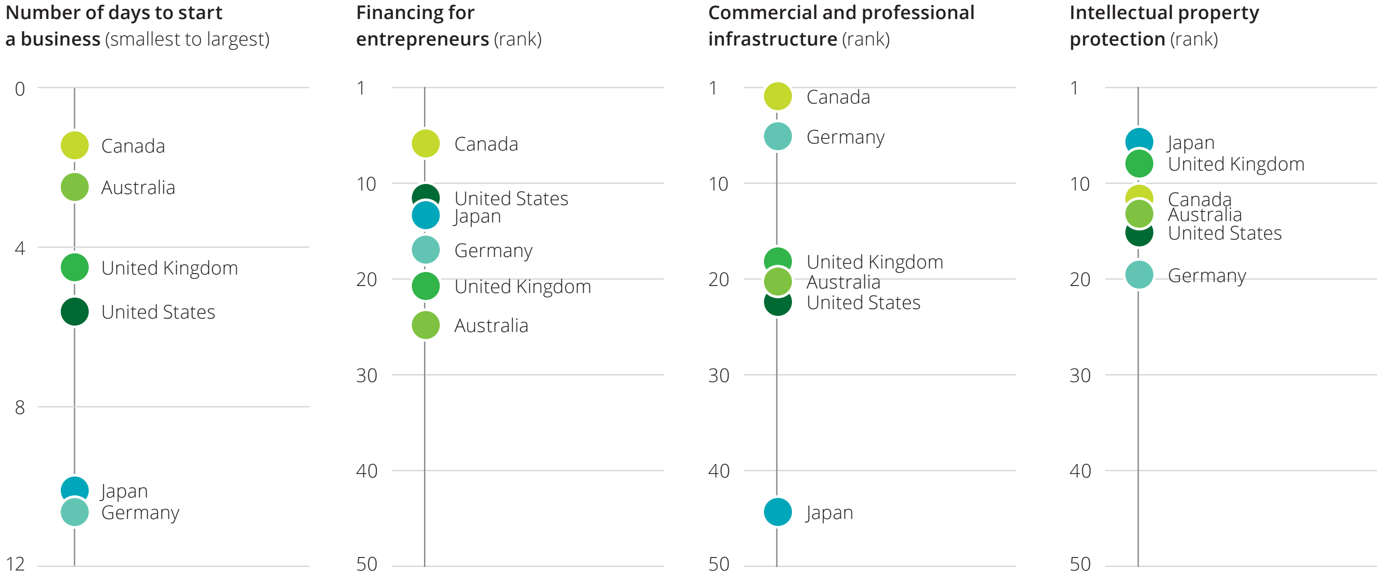
Direct enablers and barriers to start-up activity

In Australia, it is relatively easy to start a business. On average, it only takes 2.5 days and 3 procedures to start a business. However, once established, there are many potential barriers to the success of a new start-up – Australia's ordinal ranking on some of these measures compared to other developed countries is presented in Chart 5.4.

Financing for entrepreneurs in Australia is lower than in high-performing start-up economies. The advantage other countries have in the availability of financial resources is largely a factor of the size of their economy: the USA, Japan and Germany are the 1st, 3rd and 4th largest economies in the world respectively (IMF, 2018).

Australia is also relatively 'middle of the pack' in terms of commercial and professional infrastructure (e.g. business support services) and for intellectual property protection. These factors are important supports that help increase the likelihood of start-ups' survival. Countries with strong supporting infrastructure and intellectual property protection tend to attract more investment into new technologies and business (Hassan, Yaqub, Diepeveen, 2010)

Chart 5.4: Ordinal ranking of Australia and selected 'high-performing' start-up countries on factors relating to start-up operations



Sources: Deloitte Access Economics analysis of the Global Entrepreneurship Monitor National Expert Survey (2017) and the World Economic Forum Network Readiness Index (2016)

Market conditions for success

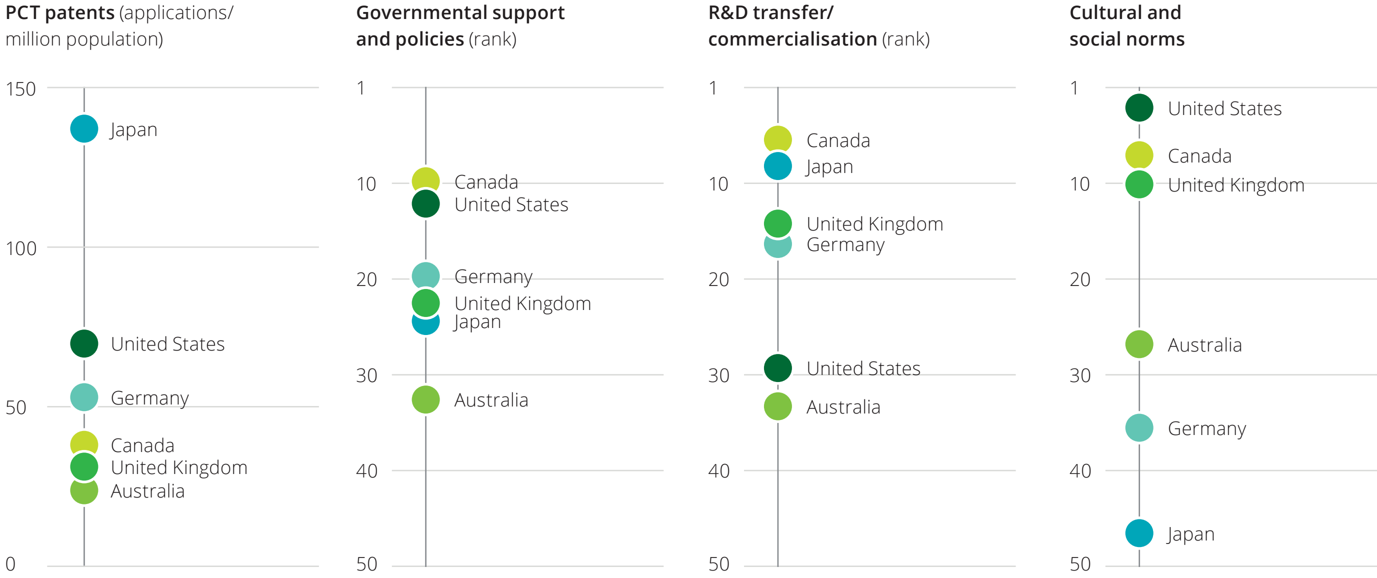
Australia performs comparatively poorly on indicators of market conditions for success. As the ordinal rankings presented in Chart 5.5 show, Australia is the lowest ranked country on three of the four indicators identified. Australia displays a lower capacity to exploit knowledge and translate it into potential economic gains, as reflected through its ranking in Patent Cooperation Treaty (PCT) patents per million population (European Commission, 2016).

Australia also does not rate well on government support and policies, implying lower support for entrepreneurial activities than in the comparison countries. Relatedly, government procurement of technologies in Australia is very low, ranking 70th out of 149 countries in 2016. Further, the extent to which government does support innovation through national research and development (R&D) translates into fewer new commercial opportunities for smaller businesses than in high-performing start-up countries.

Overall, start-ups are an important driver of innovation in Australia's digital ecosystem. With over 1,700 start-ups operating across a range of technologies and locations in Australia, it is difficult to conclude whether this activity is about the right level – particularly as innovation comes not only from start-ups but also from existing businesses doing a better job of integrating emerging technologies into their core strengths (Hillard, 2016).

At the same time, this analysis suggests that Australia could be doing more to facilitate start-up activity, particularly when compared to the environments in other developed countries. This might include more targeted initiatives to embed tech start-up activity in non-tech industry growth precincts, and improving the start-up investment landscape (discussed in Section 5.3). These findings are consistent with international comparisons in the latest *Global Startup Ecosystem Report 2019*, which ranked Sydney as number 23 in the top 30 global start-up ecosystems (a decline of 6 places compared to the previous year), and Melbourne outside this top 30 (Startup Genome, 2019).

Chart 5.5: Ordinal ranking of Australia and selected 'high-performing' start-up countries on factors relating to market conditions



Sources: Deloitte Access Economics analysis of the Global Entrepreneurship Monitor National Expert Survey (2017)

5.3 Tax policy and implications for digital investment

Why is it important to get tax policy settings right?

There is evidence that R&D investment and ICT adoption plays a role in driving growth and innovation and therefore improving living standards over time. Digital investment drives increases in multifactor productivity which in-turn results in an increase in per capita income (OECD, 2010). Recent research published by the Reserve Bank of Australia suggests that this is increasingly true as new technologies see broadening applications across Australian industries, with different rates of adoption of and investment in technology having greater influence in determining productivity and wages growth (Weir, 2018).

A range of government policy settings may influence digital investment including general market and competition policies, the overall level of regulation and financial incentives, including tax rules. Spillover effects from investing in new technologies, assets and building digital capabilities may justify government intervention (Bakhtiari and Breunig, 2017). Moreover, in a globally connected world where capital is mobile across country borders, Australia needs to remain internationally competitive in order to attract foreign investment and ensure that Australian investors have suitable onshore opportunities rather than going offshore. The alternative would be risking future growth in our digital workforce and economy, if this forecast growth is not matched by investment in digital technologies at the required pace.

Tax policies and financial incentives that aim to stimulate digital investment and innovation cannot be viewed in isolation. They must take into account factors that affect decision-making such as the size or rate of the benefit, who receives the benefit (e.g. the company itself or the individual investors) and the timing of the benefit (e.g. upfront or deferred). The 2018 *Digital Pulse* examined international examples of tax policies that target digital investment, including in Canada, the US, Italy, UK and Singapore. It found that these countries have discrete examples of favourable tax settings for encouraging digital investments. For the 2019 *Digital Pulse*, we directly compare Australia to two similar developed countries just as a business or individual might when weighing up an investment decision.

Whilst there has been a lot of activity in the Australian policy landscape around ICT development, digital growth and innovation over the last few years, Australia does not have a tax policy framework developed with digital investments in mind. It is important to benchmark these policies relative to other developed countries that are leading the way in the digital investment space to see how we stack up and where policy improvements can be made.

Capital investment in early-stage technology companies

As discussed in Section 5.2, early-stage or 'start-up' technology companies are important sources of innovation. They disrupt the environment in which they operate, improve productivity and create jobs and growth. But as previously mentioned, an estimated 97% of start-ups will either exit or fail to commercialise and scale, with failure often occurring between initial funding and commercialisation due to difficulties attracting investment (McLeod, 2017). Bridging this "valley of death" gap and matching firms with early stage investment to assist with commercialisation is a major policy imperative for governments looking to promote digital innovation.

In 2016, as part of the National Innovation and Science Agenda, the Australian Government introduced the Early Stage Innovation Companies (ESIC) scheme in order to support innovative, high-growth companies by matching investors that have the requisite funds and business experience with entrepreneurs that are seeking to commercialise their ideas (Department of the Treasury, 2016). It is a general scheme that is available to all companies that demonstrate "innovation that benefits Australia"; however, it is particularly suited to tech start-ups that are seeking capital early on.

The ESIC scheme provides eligible investors with a 20% upfront tax relief on the amount invested, capped at a maximum annual tax offset of $200,000 which may be carried forward against future years. Investors will also not have to pay capital gains tax if the shares increase in value, as long as the shares have been held continuously for at least 12 months and less than 10 years. Companies that qualify for ESIC investment must meet a number of requirements related to company size and expenditure, date of establishment and whether it meets certain innovation criteria (ATO, 2016). Based on ATO tax return data, approximately $300 million was invested in 340 companies in the financial year 2016-17 (Sadler, 2018).

The ESIC scheme is very similar to the UK's Enterprise Investment Scheme (EIS); as such, the UK offers a benchmark for which we can gauge the attractiveness of Australia's tax policy in stimulating investment in early stage technology companies. The EIS was introduced in 1994 to help small, high-risk companies raise finance by offering a range of tax reliefs to investors purchasing shares in those companies. A similar Seed Enterprise Investment Scheme (SEIS) was introduced to complement the EIS and help smaller, earlier stage companies attract investment by offering tax relief at a higher rate than the EIS. The OECD has previously stated that both the EIS and SEIS are examples of "existing successful policies... designed to help support small and growing higher-risk businesses" (OECD, 2014).

In 2016-17, 3,470 companies raised a total of approximately £1.8 billion under the EIS scheme, while 2,260 companies received a total of £175 million under the SEIS scheme. Both schemes are general in nature and available to all start-up companies that meet the prescribed criteria; however, take-up is generally skewed towards the ICT sector – according to the Enterprise Investment Scheme Association (EISA), the ICT sector represented over a third of all EIS and SEIS investment in 2016-17.

Given the similarities between the EIS, SEIS and ESIC, it is interesting to note the substantial difference in the number of companies receiving funding under the different schemes. A key reason for this difference is likely to be the fact that the ESIC scheme is in its relative infancy when compared to the EIS scheme. Second, as Table 5.1 illustrates, accessing the ESIC scheme can be quite difficult when compared to the EIS, as the thresholds for date of establishment and company size are much tighter. Further, there is anecdotal evidence to suggest the ESIC scheme is difficult to understand, with many entrepreneurs unware of its existence (Bailey, 2017).

Table 5.1: Comparison of EIS and SEIS eligibility criteria

Scheme	Number of employees	Date of establishment	Assets, income or expense thresholds	Previous investment
ESIC (Aus)	N/A	Registered in the Australian Business Register within the last three income years	Income of $200,000 or less and total expenses of $1 million or less	N/A
EIS (UK)	Less than 250 employees	Trading for less seven years (10 years for 'knowledge-intensive companies')	No more than £1 million in gross assets	N/A
SEIS (UK)	Less than 25 employees	Trading for less than two years	No more than £200,000 in gross assets	No previous venture capital investment.

Source: EISA (2017)

In order to compare how these schemes affect the returns to investments in early-stage tech companies, Table 5.2 outlines a stylised and high-level scenario wherein an investor is faced with a choice of making an investment in an early-stage tech company in Australia or the UK. For the purposes of this scenario, we have assumed an initial investment of $200,000 and a conservative 10% growth in share value per annum.

Given the magnitude of the initial upfront offset, the SEIS outperforms the EIS and ESIC scheme in terms of return on investment. However, this is a simplified scenario and effective returns may also be commensurate with the risk involved. This is especially the case for very early stage or "seed" companies (that are targeted by the SEIS) that have a much higher risk of failure than companies on the edge of commercialisation.

Moreover, this high-level scenario only considers headline rates of tax relief and does not capture other constraints that may be relevant for an investor comparing these programs across Australia and the UK – such as the criteria and ease of accessing each scheme (discussed above). While a stylised scenario such as that presented in Table 5.2 is limited in the extent to which such broader considerations can be captured, these criteria and other factors that may affect the eligible tax base and the investment environment would all need to be incorporated into an investor's decision making process.

Encouraging investments in technology by Australian businesses

As discussed previously, government support for digital investment can be warranted if the private market fails to provide the socially optimal amount of investment due to spillover effects. The R&D tax incentive is the Australian Government's largest tax policy that aims to incentivise firms to undertake additional R&D activities and rectify this market failure.

Table 5.2: Stylised scenario – Early stage investment in Australia vs. UK

	Australia (ESIC)	UK (EIS)	UK (SEIS)
Initial investment *(amount assumed)*	$200,000	$200,000	$200,000
Income tax relief	20% upfront offset	30% upfront offset	50% upfront offset
Net initial investment	$160,000	$140,000	$100,000
Value of shares after 3 years *(10% growth p.a. assumed)*	$266,200	$266,200	$266,200
Capital gain after 3 years*	$106,200	$126,200	$166,200
Effective annual return on net investment after 3 years	**18.5%**	**23.9%**	**38.6%**

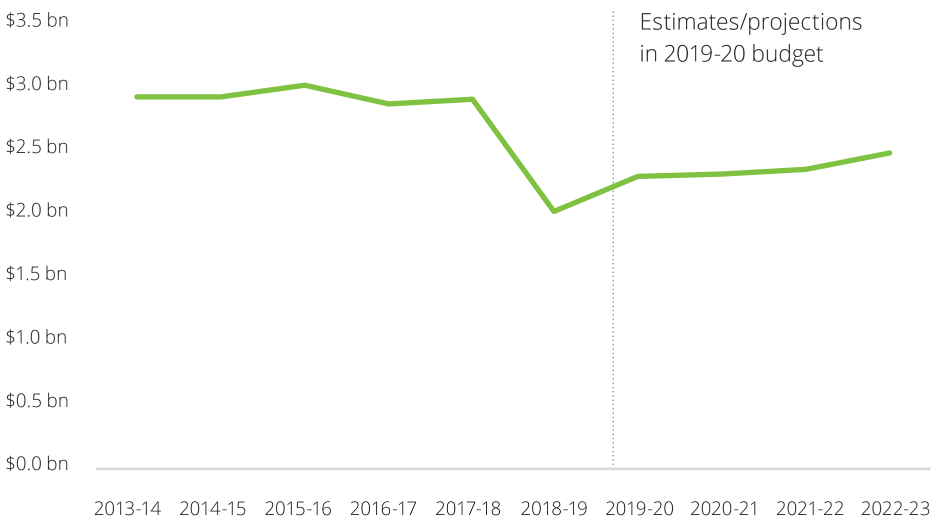
* As the shares have been held for over 12 months, investors are exempt from CGT in all three cases.

Australia offers a broad-based R&D tax credit to offset some of a company's cost of doing eligible R&D activities. A refundable 43.5% tax offset is available to eligible SMEs and a non-refundable 38.5% tax offset for larger entities. The refundable tax offset means that eligible SMEs are able to receive a cash refund of their R&D credit if they are operating in a tax loss position (DIIS, 2019a), and this cash can be reinvested back into the business.

Eligible R&D activities are defined as "experiments that are guided by hypotheses and conducted for the purpose of generating new knowledge" (DIIS, 2019b). Most expenditures related to R&D activities are eligible, including salaries, overheads and depreciation of machinery. Whilst the tax incentive is available to all companies undertaking R&D, around half of the funding is allocated to activities in industry production and technology (DIIS, 2018b).

In 2016-17, 15,177 companies registered for R&D activities with total registered R&D expenditure of $13.7 billion for the period. Government R&D tax incentive expenditure was estimated to be approximately $2.8 billion (DIIS, 2018a). However, expenditure on this scheme has fallen since 2016-17, following the Australian Government's changes to the R&D tax incentive and increased regulatory activity (Chart 5.6). R&D incentive expenditure is expected to remain at this relatively lower level in the near term, with the 2019-20 Federal Budget forward estimates suggesting further falls, in addition to the $2.9 billion funding reduction announced in the 2018-19 Budget (Durkin and Potter, 2019). Consultations with industry experts suggest that tighter administration of the program has made it difficult for smaller technology companies to confidently access the scheme and this has reduced the number of R&D claims made.

Chart 5.6: Government R&D tax incentive expenditure



Sources: DIIS (2018b), Federal Budget 2019-20

We can evaluate the current incentives for businesses seeking to invest in research and innovation activities in Australia relative to a comparable developed country in order to assess the attractiveness of Australia's policy settings. Canada is used for this comparison: widely recognised as one of the most favourable R&D tax credit programs in the world, Canada's Scientific Research and Experimental Development (SR&ED) program accounts for 74% of total government support for R&D (OECD, 2017). An earlier review of the SR&ED program found that every $1 of tax credit provided results in at least $1.5 of additional R&D spending in Canada (Cookson, 2018).

The SR&ED program, introduced in 1985, is the largest source of Canadian Government support for research and development in Canada, providing over C$2.7 billion in investment tax credits to approximately 21,000 claimants in 2016-17 (CRA, 2017). Of these, roughly 75% are small businesses (CRA, 2019). Whilst the incentive is broad-based, the major beneficiaries of this incentive are businesses in Manufacturing, Information and Cultural, and Professional, Scientific and Technical Services industries (CRA, 2018a). It provides Canadian Controlled Private Corporations (CCPCs) with a refundable tax credit of up to 35% on eligible R&D expenditures, capped at $3 million, which can be applied to reduce a company's tax liability (CRA, 2019).

Table 5.3 provides a high-level simplified scenario between an Australian small or medium-sized enterprise (SME) and Canadian CCPC SME looking to make a $1 million digital investment to facilitate its research and innovation. We have made some other assumptions around the SME's income ($4 million) and total expenses ($2 million) for the purposes of this scenario. It is also important to note that this investment decision is related to some other tax settings, such as the corporate tax rate, which have been included in the comparison where relevant.

Table 5.3: Stylised scenario – SME investment in R&D in Australia vs. Canada

	Australia (R&D Tax Incentive)	**Canada (SR&ED)**
1. SME corporate tax rate	27.5%	10%
2. R&D incentive rate	43.5% offset on taxable income	35% refundable tax credit on expenses
3. Eligible R&D expenditure *(amount assumed)*	$1,000,000	$1,000,000
4. Tax offset (Aus)/Tax credit (Canada) *(2x3)*	$435,000	$350,000
5. SME turnover *(amount assumed)*	$4,000,000	$4,000,000
6. Total expenses *(amount assumed)*	$2,000,000	$2,000,000
7. Taxable income *(5–6, with add-back of R&D expenses in Australia)*[1]	$3,000,000	$2,000,000
8. Tax liability *(1x7)*	$825,000	$200,000
9. Adjusted tax liability after R&D tax offset/credit (8-4)	$390,000	$0[2]
Effective tax rate	**13%**	**0%**

Notes:

1. For the Australian R&D tax incentive, a business must add R&D expenditure that is being claimed under the scheme back into their calculation of taxable income (DIIS, 2018c), i.e. $2,000,000 + $1,000,000 = $3,000,000. By contrast in Canada, SR&ED expenditures that are being claimed can also be deducted in the calculation of taxable income (CRA, 2018b).

2. If the tax credit exceeds the tax liability, the remaining tax credit can be used as a cash payment to the business; however, this only applies if taxable income is less than $400,000.

Canada's SR&ED tax credit is found to be highly favourable for SMEs in this scenario. Although Australia has a prima facie higher R&D tax incentive rate, the Canadian tax landscape lends itself to further digital investment due to the combination of (i) a lower SME corporate tax rate and (ii) the deductibility of R&D expenses that are also being claimed for the tax credit. As a result, SMEs that are seeking to invest in digital technologies as part of their research and innovation agenda could experience a significantly lower effective tax rate in Canada compared to Australia.[9]

Again, it should be noted that this comparison in Table 5.3 is a stylised scenario that examines headline R&D incentive and corporate tax rates, and is limited in its ability to capture broader considerations that would be relevant for a business making decisions about R&D investment in Australia and Canada. Some of these considerations include the types of expenditures that are eligible for the R&D incentive (i.e. a broader tax base), interactions with other parts of the tax system such as franking credits and capitalisation of R&D-related costs, differential impacts depending on whether a business is pre-revenue or earning revenue (for example, a pre-revenue business in Australia could be refunded with the entire tax offset), and other relevant aspects of the regulatory environment. The combination of all these factors with the headline rates will impact a business's decisions around R&D investments.

9. Note that the Canadian scheme has an annual expenditure limit of C$3 million in qualifying SR&ED expenditure. The Australian scheme is current uncapped, and while there has been a recent proposal to cap annual cash refunds at A$4 million, a Senate report has suggested that this proposal requires further review (Sadler, 2019).

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Appendix: Statistical compendium

At a glance – Australia

Table A.1: Summary of key national statistics

Indicator	Statistic	Period
Technology workers in Australia (actuals)	723,334	2018
Of which: ICT-related industry subdivisions	357,223	2018
Other industries	366,112	2018
Of which: Technical, professional, management and operational occupations	487,531	2018
Other occupations (including trades and sales)	235,803	2018
Technology workers' proportion of total workforce	5.74%	2018
Forecast size of technology workforce (trend)	792,839	2024
Inbound temporary migration of technology workers (457 and 482 visas granted)	9,917	2017–18
Net migration inflow of technology workers	20,664	2015–16
Female share of technology workers	29%	2018
Older workers' (aged 55+) share of technology workers	12%	2018
Businesses' ICT research and development expenditure	$6.6bn	2015–16
Total ICT service exports	$3.78bn	2017–18
Total ICT service imports	$3.27bn	2017–18
IT university enrolments by domestic students	36,335	2017
IT university completions by domestic students	5,958	2017
IT university enrolments by international students	43,856	2017
IT university completions by international students	9,650	2017

Source: ABS catalogues 5368.0 (2019) and 8104.0 (2018) and customised report (2019), Department of Education U-Cube (2019); Department of Immigration and Border Protection Subclass 457 Visa Statistics (2019)

At a glance – states and territories

Table A.2: Summary of key state statistics

Indicator	NSW	Vic	Qld	SA	WA	Tas	ACT	NT
Technology workers in Australia (2018)	286,978	219,073	97,780	36,477	47,597	7,264	24,980*	3,186*
Of which: ICT-related industry subdivisions	141,405	115,315	49,662	16,546	21,121	3,333	N/A	N/A
Other industries	145,573	103,758	48,118	19,931	26,476	3,931	N/A	N/A
Of which: Technical, professional, management and operational occupations	193,393	149,748	62,558	24,022	31,694	4,712	19,537*	1,867*
Other occupations (including trades and sales)	93,585	69,325	35,222	12,454	15,903	2,552	5,443*	1,319*
Technology workers' proportion of total workforce (2018)	7.2%	6.6%	3.9%	4.3%	3.5%	2.9%	N/A	N/A
IT university enrolments by domestic students (2017)	12,617	10,911	7,010	1,943	1,795	360	1,456	112
IT university completions by domestic students (2017)	2,314	1,699	1,017	302	267	71	269	9

* While the 2018 labour force data from the ABS contained combined figures for the NT and the ACT for confidentiality reasons, NT employment has been separated from ACT employment at an aggregate and occupational level using the Deloitte Access Economics employment forecast model.

Sources: ABS customised report (2019), Deloitte Access Economics (2019) and Department of Education U-Cube (2019)

At a glance – ICT employment

Table A.3: CIIER classification of technology workers at the four-digit Australian and New Zealand Standard Classification of Occupations (ANZSCO) level

ICT management and operations
1351 ICT managers
2232 ICT trainers
2247 management and organisation analysts
2249 other information and organisation professionals
2621 database and systems administrators, and ICT security specialists
2632 ICT support and test engineers
ICT technical and professional
2324 graphic and web designers, and illustrators
2611 ICT business and systems analysts
2612 multimedia specialists and web developers
2613 software and applications programmers
2631 computer network professionals
2633 telecommunications engineering professionals
3132 telecommunications technical specialists
ICT sales
2252 ICT sales professionals
6212 ICT sales assistants
ICT trades
3131 ICT support technicians
3424 telecommunications trades workers
Electronic trades and professional*
3123 electrical engineering draftspersons and technicians*
3124 electronic engineering draftspersons and technicians*
3423 electronics trades workers*
ICT industry admin and logistics support*
All other occupations where the employee works in an ICT-related industry subdivision (telecommunications services; internet service providers, web search portals and data processing services; and computer system design and related services)

* For these occupations, only workers employed in the ICT-related industry subdivisions (telecommunications services; Internet service providers, web search portals and data processing services; and computer system design and related services) are counted as technology workers

Sources: Australian Computer Society and CIIER

Table A.4: OECD's broad measure of ICT-skilled employment at the four-digit ANZSCO level

1111 chief executives and managing directors	2349 other natural and physical science professionals
1112 general managers	2512 medical imaging professionals
1311 advertising and sales managers	2600 ICT professionals nfd
1320 business administration managers not further defined (nfd)	2610 business and systems analysts, and programmers nfd
1322 finance managers	2611 ICT business and systems analysts
1323 human resource managers	2612 multimedia specialists and web developers
1324 policy and planning managers	2613 software and applications programmers
1332 engineering managers	2621 database and systems administrators, and ICT security specialists
1335 production managers	2630 ICT network and support professionals nfd
1336 supply and distribution managers	2631 computer network professionals
1351 ICT managers	2632 ICT support and test engineers
1419 other accommodation and hospitality managers	2633 telecommunications engineering professionals
1494 transport services managers	2710 legal professionals nfd
2210 accountants, auditors and company secretaries nfd	2711 barristers
2211 accountants	2712 judicial and other legal professionals
2212 auditors, company secretaries and corporate treasurers	2713 solicitors
2220 financial brokers and dealers, and investment advisers nfd	3100 engineering, ICT and science technicians nfd
2221 financial brokers	3123 electrical engineering draftspersons and technicians
2222 financial dealers	3124 electronic engineering draftspersons and technicians
2223 financial investment advisers and managers	3130 ICT and telecommunications technicians nfd
2232 ICT trainers	3131 ICT support technicians
2241 actuaries, mathematicians and statisticians	3132 telecommunications technical specialists
2242 archivists, curators and records managers	3400 electrotechnology and telecommunications trades workers nfd
2243 economists	3420 electronics and telecommunications trades workers nfd
2244 intelligence and policy analysts	3423 electronics trades workers
2246 librarians	5100 office managers and program administrators nfd
2247 management and organisation analysts	5121 office managers
2249 other information and organisation professionals	5122 practice managers
2251 Advertising and marketing professionals	5211 personal assistants
2252 ICT sales professionals	5212 secretaries

2320 architects, designers, planners and surveyors nfd	5321 keyboard operators
2321 architects and landscape architects	5510 accounting clerks and bookkeepers nfd
2322 cartographers and surveyors	5511 accounting clerks
2326 urban and regional planners	5512 bookkeepers
2331 chemical and materials engineers	5513 payroll clerks
2332 civil engineering professionals	5521 bank workers
2333 electrical engineers	5522 credit and loans officers
2334 electronics engineers	5523 insurance, money market and statistical clerks
2335 industrial, mechanical and production engineers	6111 auctioneers, and stock and station agents
2336 mining engineers	6112 insurance agents
2341 agricultural and forestry scientists	6212 ICT sales assistants
2342 chemists, and food and wine scientists	6399 other sales support workers
2343 environmental scientists	7123 engineering production systems workers
2344 Geologists and geophysicists	2349 other natural and physical science professionals
2345 life scientists	

Source: OECD (2012)

Table A.5: Technology workers by industry and CIIER occupational grouping, 2018

	ICT management and operations	ICT technical and professional	ICT sales	ICT trades	Electronic trades and professional	ICT industry admin and logistics support	Total technology workers
Industry divisions							
Agriculture, forestry and fishing	1,000	239	0	109	0	0	1,348
Mining	2,584	956	0	847	0	0	4,387
Manufacturing	7,367	12,436	738	2,020	0	0	22,561
Electricity, gas, water and waste services	5,251	3,909	259	831	0	0	10,251
Construction	1,979	2,004	0	4,055	0	0	8,038
Wholesale trade	4,700	5,000	2,600	1,300	0	0	13,600
Retail trade	5,604	7,758	6,732	3,710	0	0	23,804
Accommodation and food services	1,143	1,135	119	661	0	0	3,058

	ICT management and operations	ICT technical and professional	ICT sales	ICT trades	Electronic trades and professional	ICT industry admin and logistics support	Total technology workers
Transport, postal and warehousing	4,973	4,231	0	1,132	0	0	10,336
Rest of information media and telecommunications*	1,098	7,240	427	1,292	0	0	10,057
Financial and insurance services	22,115	24,944	106	4,084	0	0	51,248
Rental, hiring and real estate services	1,819	1,355	0	589	0	0	3,763
Rest of professional, scientific and technical services**	41,560	37,685	332	3,535	0	0	83,112
Administrative and support services	4,047	4,522	224	285	0	0	9,078
Public administration and safety	31,352	15,776	0	6,957	0	0	54,085
Education and training	8,325	9,573	381	5,904	0	0	24,184
Healthcare and social assistance	9,544	4,517	104	4,513	0	0	18,678
Arts and recreation services	1,751	3,907	0	724	0	0	6,381
Other services	2,455	1,834	119	1,645	0	0	6,054
ICT industry subdivisions							
Telecommunications services	13,147	19,990	7,127	20,239	1,036	40,110	101,649
Internet service providers, web search portals and data processing services	1,753	1,669	0	314	0	2,923	6,659
Computer system design and related services	39,528	103,069	13,050	26,325	3,154	63,789	248,915
Total technology workers	**212,952**	**274,579**	**32,842**	**91,949**	**4,190**	**106,822**	**723,334**

* Excluding telecommunications services, and internet service providers, web search portals and data processing services, which are separately identified as ICT industry subdivisions.

** Excluding computer system design and related services, which is separately identified as an ICT industry subdivision.

Source: ABS customised report (2019)

Table A.6: Trend technology employment forecasts by occupation grouping, 2018–24

Occupation grouping	2018	2024	Average annual growth (%)
ICT management and operations	203,817	243,789	3.0
ICT technical and professional	262,801	305,692	2.6
ICT sales	31,433	34,325	1.5
ICT trades	88,005	93,864	1.1
Electronic trades and professional*	4,011	4,506	2.0
ICT industry admin and logistics support*	102,240	110,663	1.3
Total technology workers	**692,307**	**792,839**	**2.3**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2019)

Table A.7: Trend technology skills forecasts by occupation grouping, 2018–24

	2018	2024	Average annual growth (%)
ICT management and operations			
Postgraduate	81,216	99,351	3.4
Undergraduate	151,170	178,672	2.8
Diploma or Advanced Diploma	60,500	70,105	2.5
Certificate III or IV	36,752	42,336	2.4
Certificate I or II	17,303	18,301	0.9
ICT technical and professional			
Postgraduate	83,925	99,606	2.9
Undergraduate	205,417	237,698	2.5
Diploma or Advanced Diploma	75,226	85,113	2.1
Certificate III or IV	39,787	45,021	2.1
Certificate I or II	19,407	20,302	0.8
ICT sales			
Postgraduate	5,760	6,976	3.2
Undergraduate	13,443	15,525	2.4
Diploma or Advanced Diploma	5,804	6,698	2.4
Certificate III or IV	4,505	5,069	2.0
Certificate I or II	2,320	2,337	0.1

	2018	2024	Average annual growth (%)
ICT trades			
Postgraduate	25,037	30,036	3.1
Undergraduate	47,632	54,684	2.3
Diploma or Advanced Diploma	27,084	29,862	1.6
Certificate III or IV	34,327	35,765	0.7
Certificate I or II	15,613	14,563	-1.2
Electronic trades and professional			
Postgraduate	403	517	4.2
Undergraduate	1,036	1,234	3.0
Diploma or Advanced Diploma	1,225	1,458	3.0
Certificate III or IV	2,116	2,397	2.1
Certificate I or II	817	846	0.6
ICT industry admin and logistics support			
Postgraduate	21,097	25,530	3.2
Undergraduate	45,010	52,471	2.6
Diploma or Advanced Diploma	23,577	26,728	2.1
Certificate III or IV	23,115	25,016	1.3
Certificate I or II	9,839	10,180	0.6

Source: Deloitte Access Economics (2019)

Technology worker migration

Table A.8 Temporary skilled migration (457 & 482) visa grants for technology occupations, 2014–15 to 2017–18

	2014–15	2015–16	2016-17	2017-18
1351 ICT managers	939	919	852	524
2232 ICT trainers	10	15	22	16
2247 Management and organisation analysts	1,445	1,345	1,362	990
2249 Other information and organisation professionals	452	399	350	177
2252 ICT sales professionals	527	531	604	376
2324 graphic and web designers, and illustrators	472	411	459	220
2611 ICT Business and items analysts	2,098	2,208	2,125	1,709

	2014–15	2015–16	2016-17	2017-18
2612 multimedia specialists and web developers	162	133	121	55
2613 Software and applications programmers	5,231	4,984	4,909	3,900
2621 Database and systems administrators, and ICT security specialists	383	385	424	269
2631 Computer network professionals	272	260	294	257
2632 ICT support and test engineers	767	854	864	829
2633 telecommunications engineering professionals	127	99	81	48
3123 electrical engineering draftspersons and technicians	351	353	305	177
3124 electronic engineering draftspersons and technicians	127	99	71	N/A
3131 ICT support technicians	320	291	273	143
3132 telecommunications technical specialists	52	43	79	99
3423 electronic trades workers	115	80	94	90
3424 telecommunications trades workers	102	121	117	38
Total technology workers*	**13,937**	**13,521**	**13,406**	**9,917**

* Excludes ICT industry admin and logistics support, for which breakdowns are unavailable; electronic trades and professional data is for all industries.

Source: Department of Home Affairs 457 and 482 Visa Statistics (2019)

Table A.9: Net migration of technology workers dataset is no longer published.

ICT higher and vocational education

Table A.10: Domestic enrolments and completions in IT degrees, 2001–17

	Course enrolments		Course completions	
	Undergraduate	Postgraduate	Undergraduate	Postgraduate
2001	35,661	10,161	5,451	2,850
2002	36,647	10,280	6,219	3,294
2003	35,172	9,118	6,580	2,588
2004	31,232	8,139	6,283	2,272
2005	26,527	6,923	5,696	1,976
2006	22,762	6,101	4,672	1,642
2007	20,709	5,488	4,185	1,474
2008	18,905	5,077	3,577	1,349

	Course enrolments		Course completions	
	Undergraduate	Postgraduate	Undergraduate	Postgraduate
2009	18,545	5,143	3,159	1,315
2010	18,966	5,213	3,050	1,275
2011	19,902	5,386	3,266	1,353
2012	21,047	5,562	3,339	1,326
2013	22,055	5,447	3,463	1,423
2014	23,829	5,560	3,638	1,468
2015	25,700	5,482	3,949	1,491
2016	26,596	5,774	3,985	1,517
2017	29,993	6,342	4,405	1,553

Source: Department of Education U-Cube (2019)

Table A.11: International enrolments and completions in IT degrees, 2001–17

	Course enrolments		Course completions	
	Undergraduate	Postgraduate	Undergraduate	Postgraduate
2001	17,009	10,225	2,993	3,558
2002	20,843	11,238	4,157	4,821
2003	21,701	11,087	5,659	4,337
2004	20,683	12,638	6,010	3,586
2005	17,480	13,512	5,213	5,428
2006	15,475	11,580	5,021	5,635
2007	14,415	10,265	4,433	4,258
2008	14,236	10,964	3,715	4,369
2009	15,113	12,104	3,851	4,009
2010	15,018	11,435	4,120	5,037
2011	15,108	9,452	3,996	4,528
2012	14,495	8,992	3,749	3,385
2013	13,978	10,908	3,673	3,223
2014	14,152	13,742	3,617	3,573
2015	14,217	15,406	3,516	4,537
2016	16,063	17,953	3,602	5,263
2017	19,488	24,368	4,046	5,604

Source: Department of Education U-Cube (2019)

Table A.12 Government-funded VET subject enrolments in the IT field of education, 2015–17

	2015	2016	2017
Diploma or higher	25,120	26,435	16,965
Certificate IV	11,085	10,770	10,790
Certificate III	18,275	16,335	15,930
Certificate I/II	36,615	29,620	27,600
Non-AQF	2,865	2,635	3,040

Source: National Centre for Vocational Education Research (2019)

Women in technology

Table A.13: Female technology workers by industry, 2018

	Female technology workers	Percentage of female technology workers	Percentage of female workers in all occupations
Industry divisions			
Agriculture, forestry and fishing	594	44	30
Mining	1,103	25	16
Manufacturing	8,760	39	29
Electricity, gas, water and waste services	3,589	35	23
Construction	1,432	18	12
Wholesale trade	4,967	32	33
Retail trade	7,678	32	56
Accommodation and food services	577	19	55
Transport, postal and warehousing	1,413	14	21
Rest of information media and telecommunications*	3,414	34	41
Financial and insurance services	14,107	28	49
Rental, hiring and real estate services	756	20	49
Rest of professional, scientific and technical services**	30,702	37	44
Administrative and support services	3,305	36	53
Public administration and safety	19,830	37	49

	Female technology workers	Percentage of female technology workers	Percentage of female workers in all occupations
Industry divisions			
Education and training	8,255	34	72
Healthcare and social assistance	7,191	39	79
Arts and recreation services	2,321	36	48
Other services	1,817	30	45
ICT industry subdivisions			
Telecommunications services	26,561	26	26
Internet service providers, web search portal and data processing services	1,815	27	27
Computer system design and related services	57,910	23	23
Total technology workers	**208,098**	**29**	**47**

* Excluding telecommunications services, and internet service providers, web search portals and data processing services, which are separately identified as ICT industry subdivisions.

** Excluding computer system design and related services, which is separately identified as an ICT industry subdivision,

Source: ABS customised report (2019)

Older technology workers

Table A.14: Older technology workers by CIIER occupation grouping, 2018

	Number of ICT workers aged 55+	Percentage of total technology workforce
ICT management and operations	35,328	17
ICT technical and professional	2,455	7
ICT sales	23,750	9
ICT trades	11,322	12
Electronic trades and professional	7,960	18
Total technology workers*	**80,815**	**12**

* Excludes ICT industry admin and logistics support, for which breakdowns are unavailable; electronic trades and professional data is for all industries.

Source: ABS customised report (2019)

ICT research and development

Table A.15: Business expenditure on R&D, 2010–11 to 2015–16

	2010–11	2011–12	2013–14	2015-16
Information and computing science	$5,001,174	$5,496,165	$6,073,221	$6,634,394
Engineering	$9,283,280	$8,686,256	$7,474,231	$5,538,180
Technology	$917,109	$1,235,487	$1,689,446	$1,409,803
Medical and health sciences	$928,398	$941,159	$1,123,956	$1,253,415
Chemical sciences	$275,030	$425,941	$565,758	$632,619
Agricultural and veterinary sciences	$492,921	$455,372	$533,754	$404,003
Earth sciences	$200,390	$122,476	$286,511	$166,626
Environmental sciences	$192,797	$281,155	$270,044	$158,043
Built environment and design	$209,244	$231,743	$238,591	$152,082
Commerce, management, tourism and services	$152,605	$144,273	$227,088	$110,793
Other fields of research	$253,939	$301,295	$346,838	$199,338

Source: ABS catalogue 8104.0 (2017)

Table A.16: Government expenditure on ICT R&D, 2011–12 to 2016–17

	2011–12	2012–13	2014–15	2016-17
Commonwealth ICT R&D expenditure	$314,437,000	$240,828,000	$247,462,000	$254,504,000
Commonwealth ICT share of R&D expenditure	13%	10%	11%	12%
State and territory ICT R&D expenditure	$8,596,000	$12,778,000	$20,882,000	$38,627,000
State and territory ICT share of R&D expenditure	1%	1%	2%	3%

Source: ABS catalogue 8109.0 (2018)

Trade in ICT services

Table A.17: Exports and imports of ICT services, 2012–13 to 2016–17 ($bn)

	2012–13	2013-14	2014-15	2015–16	2016-17	2017-18
Exports	1.91	2.08	2.50	2.78	2.93	3.78
Imports	1.87	2.50	2.59	2.88	2.76	3.27

Source: ABS catalogue 5368.0 (2019)

Detailed state figures

Table A.18: State breakdown of technology workers by industry, 2018

	NSW	Vic	Qld	SA	WA	Tas	ACT*	NT*
Industry divisions								
Agriculture, forestry and fishing	192	383	549	109	0	0	N/A	N/A
Mining	458	116	341	344	3,029	0	N/A	N/A
Manufacturing	9,372	6,593	4,180	1,288	735	186	N/A	N/A
Electricity, gas, water and waste services	2,411	4,018	1,620	574	1,225	300	N/A	N/A
Construction	2,353	2,558	1,707	431	681	84	N/A	N/A
Wholesale trade	8,641	4,074	1,942	475	333	0	N/A	N/A
Retail trade	9,267	8,803	3,328	529	1,467	145	N/A	N/A
Accommodation and food services	1,335	745	430	0	510	0	N/A	N/A
Transport, postal and warehousing	5,306	2,741	771	680	604	0	N/A	N/A
Rest of information media and telecommunications**	5,230	3,199	781	638	0	33	N/A	N/A
Financial and insurance services	26,380	17,082	4,037	1,095	2,370	198	N/A	N/A
Rental, hiring and real estate services	1,847	1,306	235	139	177	59	N/A	N/A
Rest of professional, scientific and technical services***	36,424	23,838	9,424	3,844	5,267	849	N/A	N/A
Administrative and support services	2,242	3,632	1,801	467	385	0	N/A	N/A
Public administration and safety	12,685	9,724	8,847	5,146	5,797	1,003	N/A	N/A
Education and training	9,816	6,621	2,891	1,978	1,421	491	N/A	N/A
Healthcare and social assistance	7,356	5,456	2,841	989	1,448	215	N/A	N/A
Arts and recreation services	1,715	1,809	1,147	738	618	245	N/A	N/A
Other services	2,541	1,059	1,247	466	408	124	N/A	N/A
ICT industry subdivisions								
Telecommunications services	37,487	36,016	13,381	5,686	6,216	980	N/A	N/A
Internet service providers, web search portals and data processing services	2,180	2,877	941	136	385	61	N/A	N/A
Computer design and related services	101,737	76,423	35,341	10,723	14,520	2,292	N/A	N/A
Total technology workers	**286,978**	**219,073**	**97,780**	**36,477**	**47,597**	**7,264**	**24,980**	**3,186**

* While the 2018 labour force data from the ABS contained combined figures for the NT and the ACT for confidentiality reasons, NT employment has been separated from ACT employment at an aggregate level using the Deloitte Access Economics employment forecast model.

** Excluding telecommunications services, and internet service providers, web search portals and data processing services, which are separately identified as ICT industry subdivisions.

*** Excluding computer system design and related services, which is separately identified as an ICT industry subdivision.

Sources: ABS customised report (2019), Deloitte Access Economics (2019)

Table A.19: NSW trend technology employment forecasts by CIIER occupation grouping, 2018–24

	2018	2024	Average annual growth rate (%)
ICT management and operations	74,957	87,016	2.5
ICT technical and professional	110,140	123,488	1.9
ICT sales	11,856	12,804	1.3
ICT trades	36,176	37,756	0.7
Electronic trades and professional*	800	867	1.4
ICT industry admin and logistics support*	40,738	44,063	1.3
Total technology workers	**274,668**	**305,994**	**1.8**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2019)

Table A.20: Victoria's trend technology employment forecasts by CIIER occupation grouping, 2018–24

	2018	2024	Average annual growth rate (%)
ICT management and operations	64,629	80,375	3.7
ICT technical and professional	78,695	91,396	2.5
ICT sales	9,588	10,263	1.1
ICT trades	21,377	22,973	1.2
Electronic trades and professional*	1,388	1,559	2.0
ICT industry admin and logistics support*	33,999	36,321	1.1
Total technology workers	**209,676**	**242,887**	**2.5**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2019)

Table A.21: Queensland's trend technology employment forecasts by CIIER occupation grouping, 2018–24

	2018	2024	Average annual growth rate (%)
ICT management and operations	27,067	32,050	2.9
ICT technical and professional	32,808	41,460	4.0
ICT sales	5,332	5,601	0.8
ICT trades	12,919	14,318	1.7
Electronic trades and professional*	914	1,049	2.3
ICT industry admin and logistics support*	14,546	16,301	1.9
Total technology workers	**93,586**	**110,780**	**2.9**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2019)

Table A.22: South Australia's trend technology employment forecasts by CIIER occupation grouping, 2018–24

	2018	2024	Average annual growth rate (%)
ICT management and operations	8,738	10,340	2.8
ICT technical and professional	14,254	16,439	2.4
ICT sales	1,161	1,288	1.8
ICT trades	5,756	5,754	0.0
Electronic trades and professional*	176	190	1.3
ICT industry admin and logistics support*	4,827	5,080	0.9
Total technology workers	**34,912**	**39,091**	**1.9**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2019)

Table A.23: Western Australia's trend technology employment forecasts by CIIER occupation grouping, 2018–24

	2018	2024	Average annual growth rate (%)
ICT management and operations	15,072	18,858	3.8
ICT technical and professional	15,263	18,795	3.5
ICT sales	2,613	3,260	3.8
ICT trades	7,585	8,696	2.3
Electronic trades and professional*	405	471	2.5
ICT industry admin and logistics support*	4,616	5,025	1.4
Total technology workers	**45,555**	**55,105**	**3.2**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2019)

Table A.24: Tasmania's trend technology employment forecasts by CIIER occupation grouping, 2018–24

	2018	2024	Average annual growth rate (%)
ICT management and operations	2,276	2,474	1.4
ICT technical and professional	2,234	2,461	1.6
ICT sales	288	326	2.1
ICT trades	1,245	1,272	0.3
Electronic trades and professional*	-	-	-
ICT industry admin and logistics support*	909	1,010	1.8
Total technology workers	**6,953**	**7,543**	**1.4**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2019)

Table A.25: Northern Territory's trend technology employment forecasts by CIIER occupation grouping, 2018–24*

	2018	2024	Average annual growth rate (%)
ICT management and operations	1,220	1,427	2.6
ICT technical and professional	566	760	5.0
ICT sales	67	62	-1.2
ICT trades	686	747	1.4
Electronic trades and professional**	38	42	2.0
ICT industry admin and logistics support**	472	507	1.2
Total technology workers	**3,049**	**3,545**	**2.5**

* While the 2018 labour force data from the ABS contained combined figures for the NT and the ACT for confidentiality reasons, NT employment forecasts have been produced separately from ACT employment forecasts using the Deloitte Access Economics employment forecast model.

** Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2019)

Table A.26: Australian Capital Territory's trend technology employment forecasts by CIIER occupation grouping, 2018–24*

	2018	2024	Average annual growth rate (%)
ICT management and operations	9,858	11,248	2.2
ICT technical and professional	8,841	10,892	3.5
ICT sales	528	721	5.3
ICT trades	2,260	2,349	0.6
Electronic trades and professional**	289	327	2.1
ICT industry admin and logistics support**	2,132	2,357	1.7
Total technology workers	**23,909**	**27,894**	**2.6**

* While the 2018 labour force data from the ABS contained combined figures for the NT and the ACT for confidentiality reasons, NT employment forecasts have been produced separately from ACT employment forecasts using the Deloitte Access Economics employment forecast model.

** Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2019)

Table A.27: State breakdown of net overseas migration of technology workers dataset is no longer published.

Table A.28: State breakdown of domestic enrolments and completions in IT degrees, 2017

	Course enrolments		Course completions	
	Undergraduate	Postgraduate	Undergraduate	Postgraduate
NSW	10,176	2,441	1,682	632
Vic	8,861	2,047	1,272	427
Qld	6,217	793	814	203
SA	1,675	268	231	71
WA	1,238	557	129	138
Tas	329	31	60	11
NT	100	12	9	0
ACT	1,263	193	198	71
Multistate	134	0	10	0

Source: Department of Education U-Cube (2018)

Table A.29: State breakdown of total domestic completions of IT degrees, 2012 to 2017

	2012 completions	2017 completions	5-year increase	Total completions in 5 years to 2017
NSW	1,583	2,314	731	9,551
Vic	1,346	1,699	353	7,894
Qld	807	1,017	210	4,754
SA	238	302	64	1,315
WA	385	267	-118	1,726
Tas	89	71	-18	319
NT	38	9	-29	85
ACT	152	269	117	1,173
Multistate	27	10	-17	79

Source: Department of Education U-Cube (2018)

Table A.30: State breakdown of international enrolments and completions in IT degrees, 2017

	Course enrolments		Course completions	
	Undergraduate	Postgraduate	Undergraduate	Postgraduate
NSW	5,949	7,762	1,102	1,602
Vic	7,873	9,456	1,551	2,212
Qld	2,135	4,665	505	1,143
SA	634	846	142	203
WA	570	745	320	179
Tas	710	375	186	82
NT	109	64	14	17
ACT	829	416	189	152
Multistate	166	39	37	14

Source: Department of Education U-Cube (2018)

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