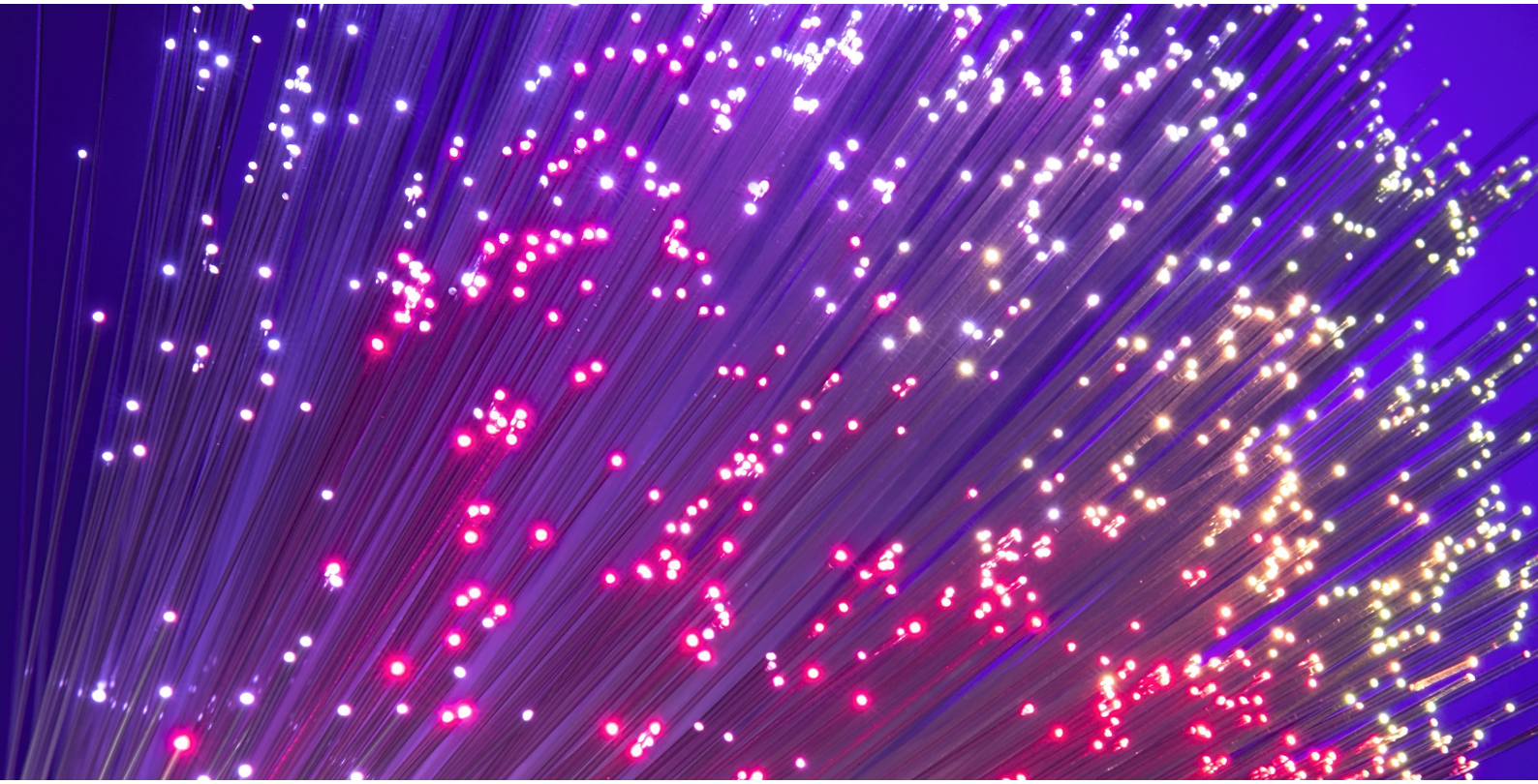
Deloitte Access Economics



Australia's Digital Pulse

Developing the digital workforce to drive growth in the future

Australian Computer Society, 2016

Deloitte.

Contents

Glossary

ABS	Australian Bureau of Statistics
ACARA	Australian Curriculum, Assessment and Reporting Authority
ACS	Australian Computer Society
AI	Artificial Intelligence
ANZSCO	Australia and New Zealand Standard Classification of Occupations
AWPA	Australian Workforce and Productivity Agency
CIIER	Centre for Innovative Industries Economic Research
DAE	Deloitte Access Economics
FY	Financial Year
GDP	Gross Domestic Product
IBSA	Innovation and Business Skills Australia
ICT	Information and Communications Technology
IMT	Information, Media and Telecommunications (ABS industry)
ITCRA	Information Technology Contract and Recruitment Association
MOOC	Massive Open Online Course
OCS	Office of the Chief Scientist
OECD	Organisation for Economic Cooperation and Development
SFIA	Skills Framework for the Information Age
UK	United Kingdom
US	United States
VET	Vocational Education and Training
WEF	World Economic Forum

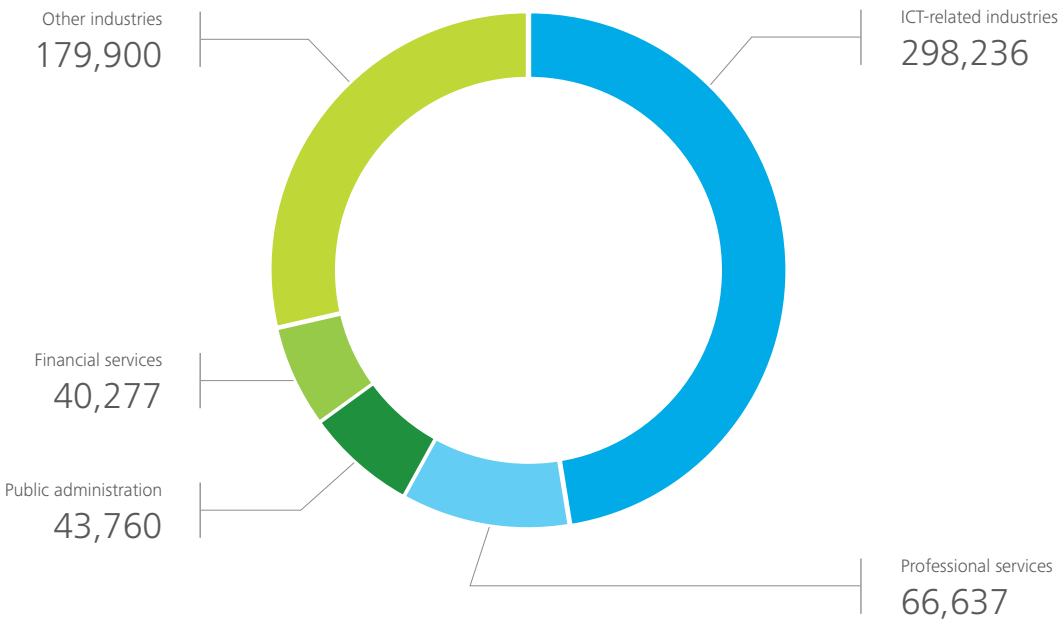
Executive summary

Australia's digital economy is expected to grow significantly over the coming years. This growth will be fuelled by new waves of technological developments. Existing technologies such as cloud services, social media and mobile devices will see growing uses in new industries, sectors and occupations. But a potentially larger source of future digital disruption will be the new technologies that are now emerging and their potential for commercial applications in the future – such as 3D printing in manufacturing, drones in the construction industry and driverless vehicles on mining sites.

The contribution of digital technologies to the Australian economy is forecast to grow from $79 billion in 2014 to $139 billion in 2020. This represents growth of over 75% and an increase in the digital economy from 5% to 7% of Australia's GDP. The vast majority of this growth (97%) is expected to take place in sectors outside of the traditional Information, Media and Telecommunications industry.

Demand for ICT workers is therefore forecast to increase in the future. **In 2015, there were around 628,000 ICT workers in Australia,[1] with 53% of this ICT workforce employed outside of ICT-related industries** such as in professional services, public administration and financial services (Chart i). This already represents higher-than-expected growth relative to the 605,000 ICT workers estimated in 2014 in *Australia's Digital Pulse 2015* – reflecting an increasing take up of ICT jobs, but also general strength in the Australian labour market and some possible sampling issues in the labour force data.

Chart i: ICT workers by selected industries, 2015



Source: ABS customised report (2015)

1. In this study, employment figures for ICT workers have been calculated using ABS occupation and industry classifications based on the methodology used in Australia's Digital Pulse 2015. This methodology draws upon definitions and nomenclature developed by the Centre for Innovative Industries Economic Research (CIIER) lead researcher, Ian Dennis FACS, and used in the 2008-2013 ACS Statistical Compendiums and other CIIER analysis.

In the future, **Australia's ICT workforce is expected to increase to around 695,000 ICT workers by 2020,** representing an average annual growth rate of 2.0% (compared to 1.4% for the workforce as a whole). However, there are several risk factors that could impact upon these figures in the future, including uncertainty surrounding global macroeconomic conditions and the effect of new technologies such as artificial intelligence.

The ICT jobs that are in high demand include a mix of technical and business-related roles. Drawing together information from the ABS, LinkedIn and industry consultations, our analysis suggests that:

- There is significant demand in the Australian labour market for technical roles such as software engineers and developers, with a number of these reflecting areas that have only emerged over recent years, such as cloud computing and cyber security.
- Demand is also high for occupations that integrate ICT systems and processes with the broader business, such as business development managers and business analysts.

While employers are demanding a range of ICT-specific skills, there is also increasing demand for ICT workers with more general skills. LinkedIn data shows that 8 of the top 20 skills demanded by employers hiring new ICT workers are broader than core technical skills, such as relationship management, customer service, strategic planning and contract negotiation. This reflects the increasing integration of ICT in core business functions, and the importance for ICT workers to consider the broader business implications associated with technological use and change.

Furthermore, **digital skills and literacy are becoming increasingly important in today's workforce more broadly,** even for workers who are not employed directly in ICT roles. According to the OECD's definition of broad ICT employment, around 2.5 million Australian workers are required to use ICT regularly as part of their jobs, reflecting the increasing pervasiveness of ICT skills in the Australian economy. LinkedIn data suggests that relevant ICT skills for the broader workforce include business-related ICT capabilities such as requirements analysis, technical ICT skills that could be useful for non-ICT workers such as SQL, and the use of common types of office software such as Windows and SAP.

Data sources and consultations

This report brings together a number of data sources in analysing the ICT skills that will be required of Australia's workforce in driving future growth and innovation. These include labour force and economic data from the ABS; LinkedIn data on jobs and skills; data from the ACS Employment Survey and skills assessments under the SFIA framework; and international ICT data from the OECD.

A number of individuals and organisations were consulted with to provide insights and case studies for this report, including representatives from Woolworths, the Commonwealth Bank of Australia, Cook Medical, the South Australian Government, the Age and Disability Discrimination Commissioner and TAFE Western Sydney.

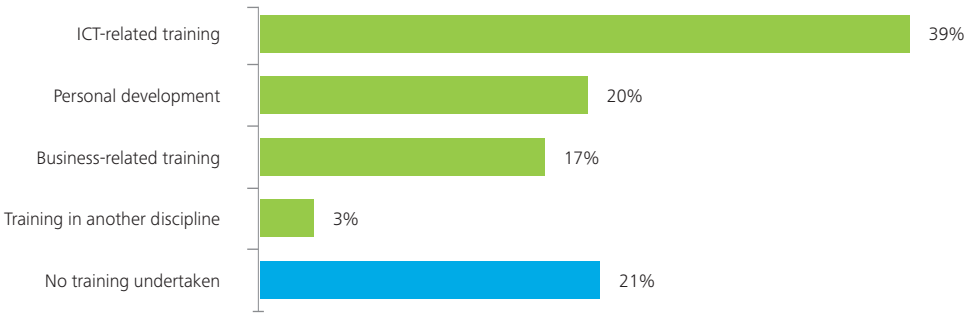
To position the Australian economy to take full advantage of the opportunities presented by new technologies, we must ensure that the workforce is equipped with the ICT skills required for innovation and growth. While ICT degree graduates have recently picked up, they represent only 1% of the existing ICT workforce each year. This suggests that **our greatest resource for developing the digital skills demanded by Australian businesses now and in the future is the current workforce.** Developing the digital skills of both existing ICT workers and the broader Australian workforce will be an important factor in ensuring that there is an adequate supply of ICT skills to support the growing digital economy.

Professional development opportunities that could be available to workers looking to upskill or reskill in ICT-related areas include formal tertiary qualifications, professional certifications, short online courses and corporate training programs. **It is important that Australian companies are engaged in ICT-related professional development.** Businesses need to be cognisant of the state of skills within their workforce, with respect to the capabilities of their employees and the skills required for them to facilitate innovation and growth in an increasingly digital world. This could involve:

- Assessing the ICT skills requirements associated with their business' products, operations and processes;
- Determining whether there are any skills gaps relative to the skillsets of their existing workforces; and
- Providing workforce development opportunities that would be most effective in addressing these gaps.

Results from the *ACS Employment Survey* show that 40% of respondents undertook ICT-related training in 2015 (Chart ii). **Companies should seek to invest in ongoing ICT-related learning and development opportunities** to ensure that employees' skillsets remain relevant as technology continues to evolve, so that workers are equipped with the digital skills required to innovate and grow the business as new technologies are developed.

Chart ii: Training undertaken in last 12 months by survey respondents*



* Survey respondents were ACS members and ICT-based members of Professionals Australia

Source: ACS Employment Survey, Professionals Australia (2015)

There may be a role for Government to highlight the importance of ICT workforce development by prioritising programs that support ICT-related skills development. This could be targeted towards specific segments of the workforce that are particularly likely to benefit from training opportunities – such as to encourage the participation of underrepresented groups such as women (who continue to represent only 28% of the ICT workforce) and older workers, which both represent an important pool of resources that should be utilised to help meet the ICT skills needs in the economy.

In 2015, there were around 62,000 ICT workers aged 55 years or older, representing 11% of the total ICT workforce. **However, technology-related age discrimination in the workforce is an issue** impacting upon both ICT workers and the broader workforce, given the prevailing stereotype that older workers have difficulties learning the new digital skills that are now required across many jobs. Targeting ICT skills development opportunities to older workers could assist in addressing these perceptions.

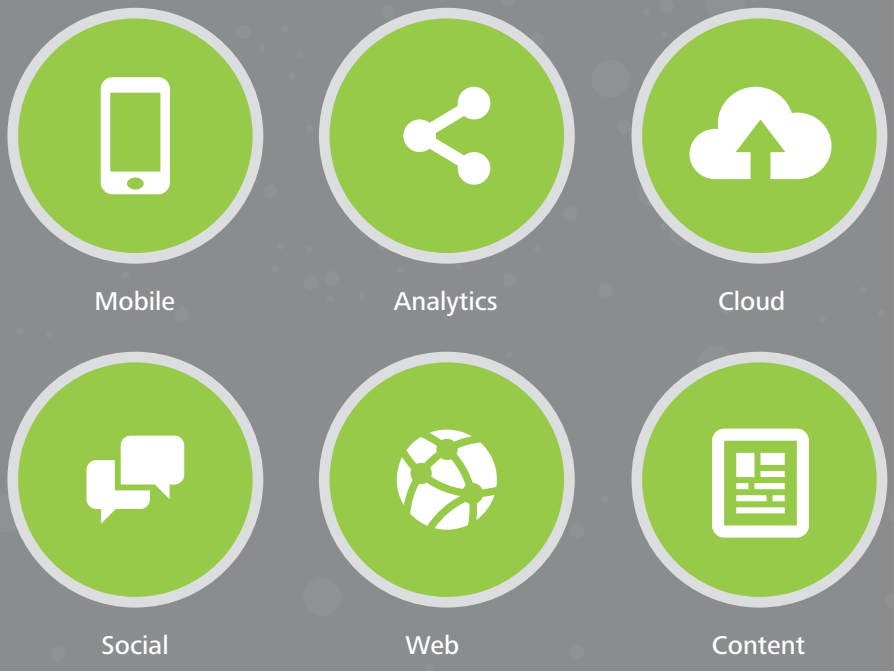
Universities and other education providers can also assist by considering how their ICT course offerings could be used to better meet employers' needs in the digital age. Given the rapidly changing nature of ICT and the digital skills required by businesses, the courses offered to students and workers may need to be adapted to these new developments in order to remain relevant in the workforce – for example, with respect to course content, length and structure.

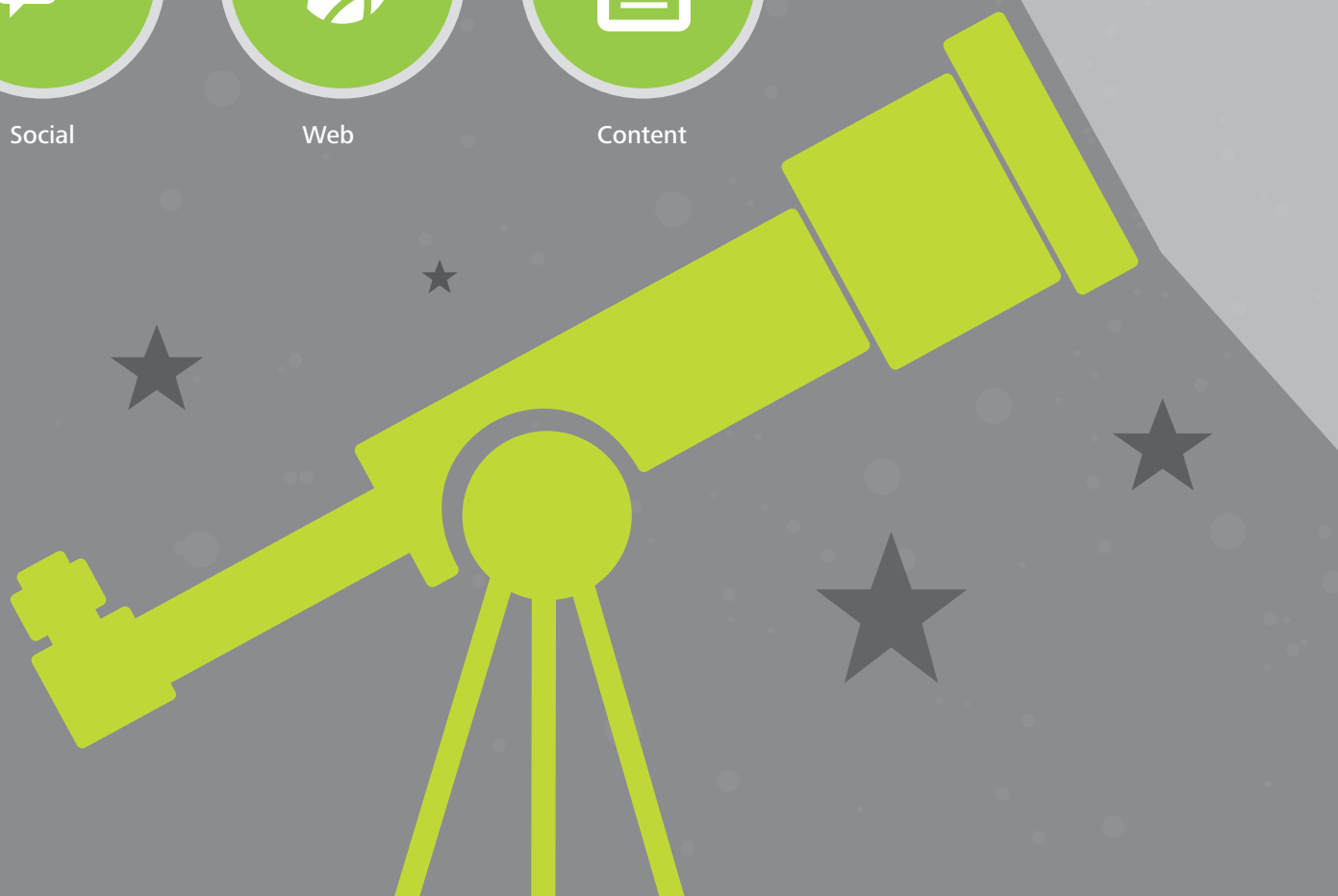
Overall, the growing demand for digital skills in Australia – with respect to both ICT workers and the broader workforce – means that **ICT-related professional development, training and education for the existing workforce must be an important part of the national conversation surrounding ICT skills.** Workforce training and development will be critical for ensuring that Australian workers are equipped with the necessary ICT skills required to drive economic growth and innovation in the face of future technological change.

1 Digital economy snapshot

This chapter examines the state of the digital economy and the ICT workforce in Australia. It discusses current and future waves of digital disruption; growth in the digital economy and ICT workers; and trends relating to ICT economic activity, migration and education.

Current wave of digital disruption





Future wave of digital disruption

1.1 Future waves of digital disruption

Digital disruption will continue to impact upon the economy in the future. Existing technologies will see growing uses in new industries, sectors and occupations; and new forms of technology will also emerge over the coming years – including 3D printing, drones, robotics and artificial intelligence.

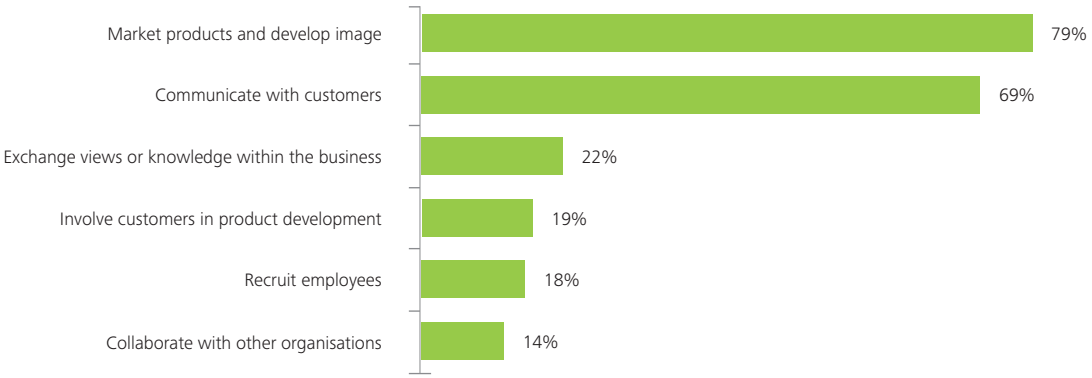
The current wave of digital disruption has seen the rise of numerous types and uses of technology across the Australian economy, including cloud computing, mobile, social media and data analytics. On top of the current wave of digital disruption taking place across many industries in the Australian economy, the potential for further disruption in the future is huge, particularly given the rapid nature of technological developments.

Technology is increasingly moving from supporting customers to being part of the core product that companies deliver to customers, particularly across industries that are not 'traditional' ICT-related sectors such as retail and energy. This could have significant economic implications for businesses, consumers and workers across Australia.

Future digital disruption and change is likely to come in two forms. First, existing technologies will see growing uses in new industries, sectors and occupations – that is, in areas where their potential is currently not being fully exploited or integrated. For example, currently only 20% of Australian businesses use cloud computing, despite a large majority (85%) of those using cloud services stating that they get a benefit from doing so, such as increased productivity, greater flexibility and reduced costs. There is therefore significant potential for other Australian businesses to take up cloud computing services to improve their operations and product offerings.

Another example is the use of social media by businesses to interact with employees and customers. Currently, only 31% of Australian businesses have a social media presence, and most of these use social media for the purposes of marketing and customer communication (Chart 1.1). As such, not only is it possible that more businesses will begin to utilise social media to engage with key stakeholders, there is also the potential that businesses who already have a social media presence will use it for more enhanced functions, such as involving customers in innovation, employee recruitment and internal and external collaboration.

Chart 1.1: Businesses' social media activities, 2013-14*



* Share of businesses with a social media presence; businesses could select more than one type of activity

Source: ABS cat. 8129.0 (2015)

Mobile devices and big data are other existing forms of technology that are likely to see growing uses across the economy over the coming years. The continuing evolution of mobile technologies in particular has delivered significant economic benefits to businesses and society more broadly, improving convenience and enhancing productivity through offering more efficient ways to manage, monitor and complete tasks. Meanwhile, data analytics is being employed in an increasing number of industries and organisations as a means to utilise the large volumes of data that can now be collected through digital channels in order to make better business decisions.

The second form of future digital disruption that we are likely to see is that new forms of technology will emerge over the coming years, and these will see various commercial applications across the Australian economy. The rapid pace of technological growth means that up-and-coming technologies could have a significant impact in facilitating change across many industries. Examples of new technology that might impact upon businesses, consumers and workers include 3D printing, drones, robotics, wearables and driverless vehicles (Figure 1.1).

Figure 1.1: New technologies disrupting the economy

Source: Deloitte Digital (2015)

These new technologies involve augmenting digital information with physical materials to create tangible machines and objects with enhanced functions. Such new technologies could disrupt new groups of sectors in different ways. Where the current wave of digital disruption has most significantly impacted upon 'knowledge jobs' such as professional services and information technology, this next wave has the potential to reach beyond these occupations and affect 'muscle power jobs' like manufacturing and construction (for examples, refer to Box 1.1). These new business applications will also impact upon the existing workforce, as employees will be required to have the skills necessary for integrating technologies such as artificial intelligence and the Internet of Things (IoT) into businesses' products, operations and processes.

Box 1.1: New technologies are disrupting new industries in innovative ways

Driverless vehicles are being used in the mining industry to automatically move commodities such as iron ore around mining sites. Use of driverless trucks removes the risks associated with humans driving over dangerous terrain, as well as reducing operating costs.

3D printing is disrupting manufacturing processes, particularly amongst smaller manufacturers as the cost of printing machines have fallen in recent years. The technology allows companies to create on-demand specialist tools and products to order, as well as enabling more rapid product development.

Drones have applications in the construction and agriculture industries, given their ability to venture where humans and heavy machinery cannot. The use of drones for monitoring sites, conducting remote surveying work and collecting site-specific aerial data can improve safety and reduce operational costs.

Wearable technology is being utilised in the healthcare industry to help individuals understand and collect data on their health at a high frequency in real time. This assists in monitoring patients and enables more timely and efficient diagnosis and treatment processes.

The implications for Australian economic growth and innovation from the application of these technologies could be significant in the future. As such, it will be important for Australian businesses, consumers and workers to be prepared for the digital disruption that is likely to continue over the coming years.

1.2 Australia's digital economy

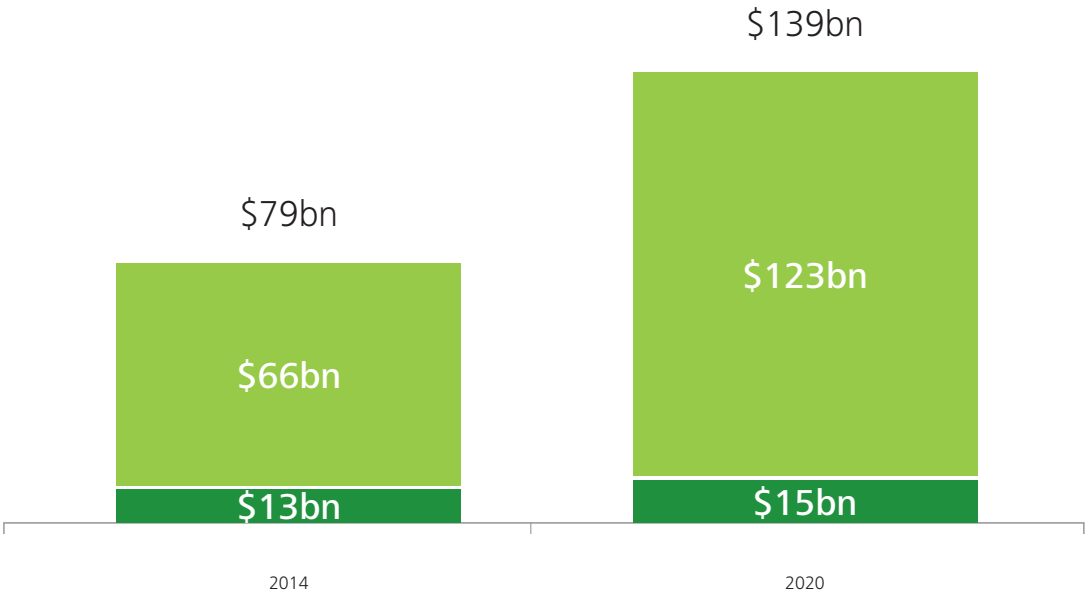
The economic contribution of the internet- and digital-enabled economy is forecast to increase from $79 billion in 2014 to $139 billion by 2020, rising from 5% to 7% of Australia's GDP. This reflects the digital pivot across the Australian economy, with new technologies disrupting businesses, consumers and workers in sectors that may not have traditionally been thought of as heavy users of technology.

The digital economy refers to the role of communications and computing power in business and the economy. As such, the digital economy encompasses a range of technologies with applications in business and across the broader economy. These include social networks, cloud platforms, mobile applications, search engine marketing and optimisation, data analytics and machine-to-machine technologies.

In 2015's edition of *Australia's Digital Pulse*, we reported that the economic contribution of the narrowly defined digital economy in Australia was estimated to be around $79 billion 2013-14, representing 5.1% of total Australian GDP. Of this total economic contribution, around $66 billion was estimated to come from the use of internet and digital technologies in industries outside of the Information, Media and Telecommunications (IMT) industry.

Deloitte Access Economics' report *The Connected Continent II: How digital technology is transforming the Australian economy* (2015) forecast that there will be significant growth in Australia's digital economy over the coming years. The economic contribution of the internet- and digital-enabled economy is forecast to increase to $139 billion by 2020, representing 7.3% of overall GDP in Australia. Importantly, almost all (97%) of this growth is expected to take place outside of the IMT industry (Chart 1.2).

Chart 1.2: Economic contribution of the digital economy, 2014 and 2020



Source: Deloitte Access Economics (2015)

This reflects the digital pivot that is impacting upon all areas of the Australian economy, with new technologies disrupting businesses, consumers and workers in sectors that may not have traditionally been thought of as heavy users of technology. Existing technologies such as cloud, mobile, social media and data analytics are finding increasing uses and functions across new industries, while emerging technologies like artificial intelligence, drones and 3D printing are generating new waves of digital disruption.

The result of this is an 'invisible digital boom' in the Australian economy, with the more traditional IMT industry contributing to only a small fraction of the future growth in Australia's digital economy. This is consistent with the Australian Government's establishment of Industry Growth Centres, which aim to increase productivity and competitiveness by focusing on areas of strategic priority across a range of industries – including advanced manufacturing; food and agribusiness; oil, gas and energy resources; and medical technologies and pharmaceuticals (Australian Government 2016). In addition to driving national action on innovation, skills and collaboration, the initiative will 'facilitate engagements between enabling services and technologies, such as Information and Communications Technology'.

The efficiency gains associated with the use of digital technologies, the potential for digital disruption to generate innovation and the diverse range of applications for various types of technology is driving the digital pivot across the Australian economy. New technological developments are facilitating change and growth in many industries, such as professional, education, healthcare and retail services – as highlighted in Box 1.2 below. As digital technologies continue to disrupt industries and businesses in the future, the economic impacts could be significant.

Box 1.2: Woolworths

Woolworths is one of the largest retailers in Australia, with an extensive network of supermarkets across the country. The company employs an ICT workforce comprising of over 2,000 internal and external professionals.

According to Clive Whincup, Chief Information Officer at Woolworths, "there is no aspect of Woolworth's business that isn't touched by technology everyday". ICT is used to improve the customer experience through the Woolworths website, online shopping and mobile applications; across the supply chain in managing distribution centres, merchandising and logistics planning; for analytics around customer behaviours and to customise product offerings to customers; and in Woolworths stores, with many interactions and information sources now utilising technologies such as smartphones and tablets.

The ICT skills that are in high demand in Woolworths include areas that have seen significant growth over recent years, including data science and analytics as well as cyber security skills. There has also been strong demand in some of the more traditional ICT occupations, including database administrators, network engineers and project management. Clive states that "change management and skills relating to business change and process are particularly important, given the amount of large-scale change associated with technological developments within Woolworths". As such, being able to communicate how technological change impacts upon the business and translate business requirements into efficient ICT processes are skills that are in high demand.

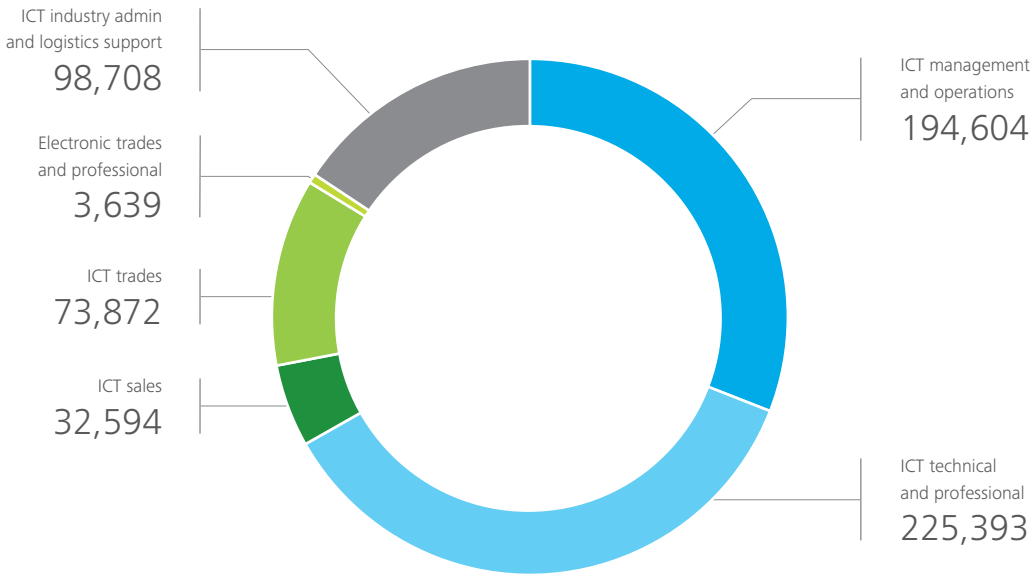
At Woolworths, the most valued skillsets are those that are able to look across traditional organisational boundaries – such as across ICT, logistics and supply chain, store planning and commercial skills. As such, the company has a tradition of rotating its employees across the business to expose workers to different learning opportunities and on-the-job training in different areas. Woolworths is also using the Skills Framework for the Information Age (SFIA) to specify skills requirements, plan career paths and map individual skillsets against the organisation's roles in a clear and visible way.

1.3 Australia's ICT workforce

There has been significant employment growth in the ICT workforce over the past year: in 2015, there were around 628,000 ICT workers in Australia, with 53% of these workers employed outside of ICT-related industries. Women continue to be underrepresented, comprising only 28% of ICT workers. Older workers aged 55 years or over represent 11% of the ICT workforce, and age discrimination related to digital skills is a large concern both amongst ICT workers and across the broader workforce.

The number of ICT workers in Australia totalled 628,810 in 2015, representing 5.4% of the total Australian labour force.[2] Around two-thirds of these workers were employed in management, operations, technical or professional roles (Chart 1.3).

Chart 1.3: ICT workers by CIIER occupation groupings, 2015



Source: ABS customised report (2015)

2. ABS industry classifications include an 'Information, Media and Telecommunications' (IMT) industry. However, in practice there are a large number of ICT 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 ICT workers (for example, publishers of print newspapers).

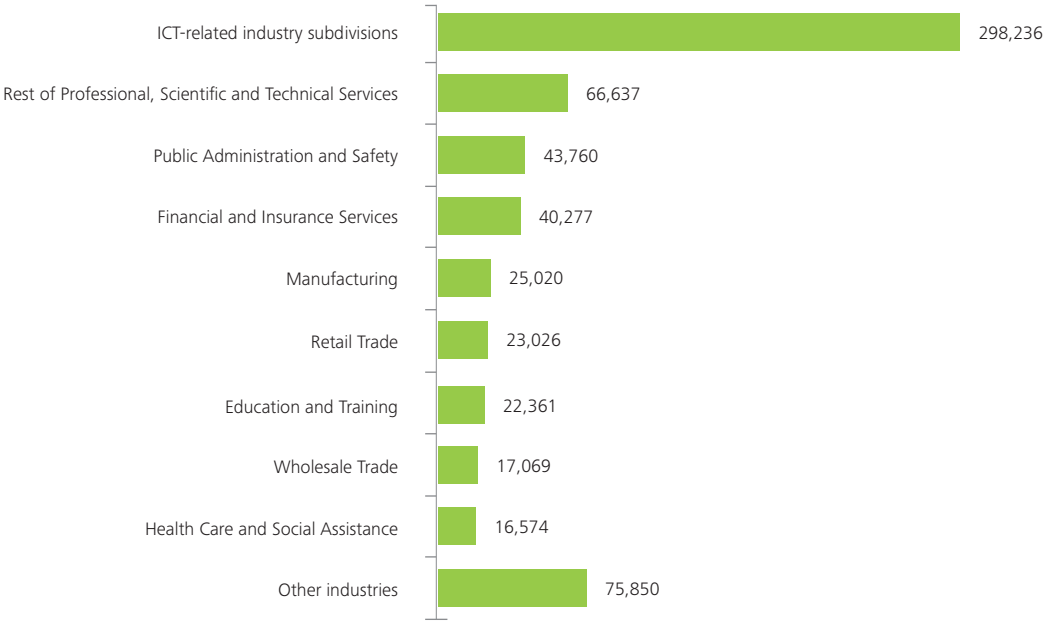
   In this study, employment figures for ICT workers have been calculated using ABS occupation and industry classifications based on the methodology used in Australia's Digital Pulse 2015. This methodology draws upon definitions and nomenclature developed by the Centre for Innovative Industries Economic Research (CIIER) lead researcher, Ian Dennis FACS, and used in the 2008-2013 ACS Statistical Compendiums and other CIIER analysis.

   For a list of which occupations and industries have been classified as ICT workers, refer to Table A.3.

An ICT workforce of around 628,800 in 2015 represents significant employment growth compared to the 605,800 ICT workers estimated in 2014 in Australia's Digital Pulse 2015. While sampling issues in the ABS labour force data mean that it can be difficult to compare these figures from year to year, the large increase is likely to partly reflect the general strength in the Australian labour market observed over the past year, as well as particular growth in the number of ICT workers.

Similar to the results reported in Australia's Digital Pulse 2015, almost half of all ICT workers are directly employed in ICT-related industries such as computer system design, telecommunications services and internet service providers. Beyond that core group, the 53% of ICT workers employed outside of ICT-related industries can be found across a range of areas, particularly in professional industries such as other professional services, public administration and financial services (Chart 1.4).

Chart 1.4: ICT workers by industry, 2015

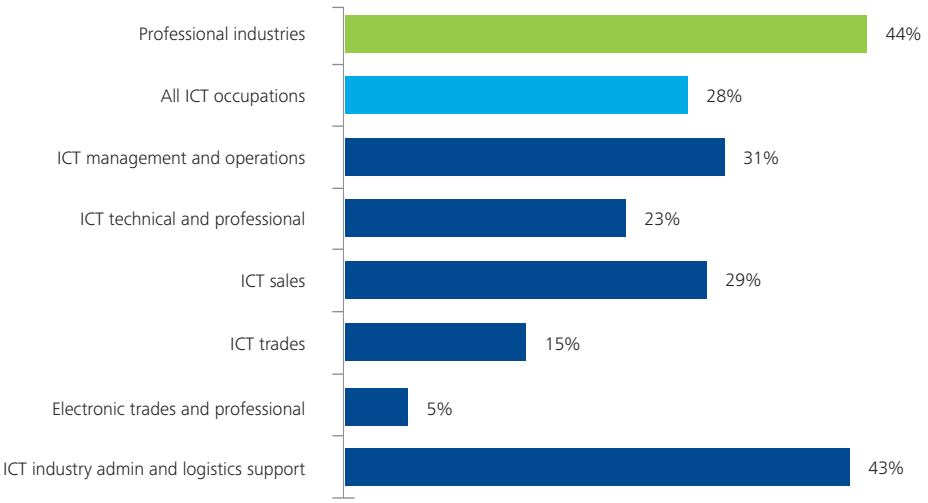


Source: ABS customised report (2015)

1.3.1 Women in ICT

Women continue to be relatively underrepresented in Australia's ICT workforce, with no improvement compared to the previous year. Females continue to comprise only 28% of all ICT workers, compared to 43% of individuals working in professional industries (Chart 1.5). Technical, operational and trades occupations such as software programmers, support technicians, systems administrators and computer network professionals continue to see relatively low levels of female representation. As was reported in *Australia's Digital Pulse 2015*, average earnings tend to be significantly lower for women in the ICT workforce compared to men, with an average pay gap of around 20%.

Chart 1.5: Share of women in ICT occupations, 2015



Source: ABS customised report (2015)

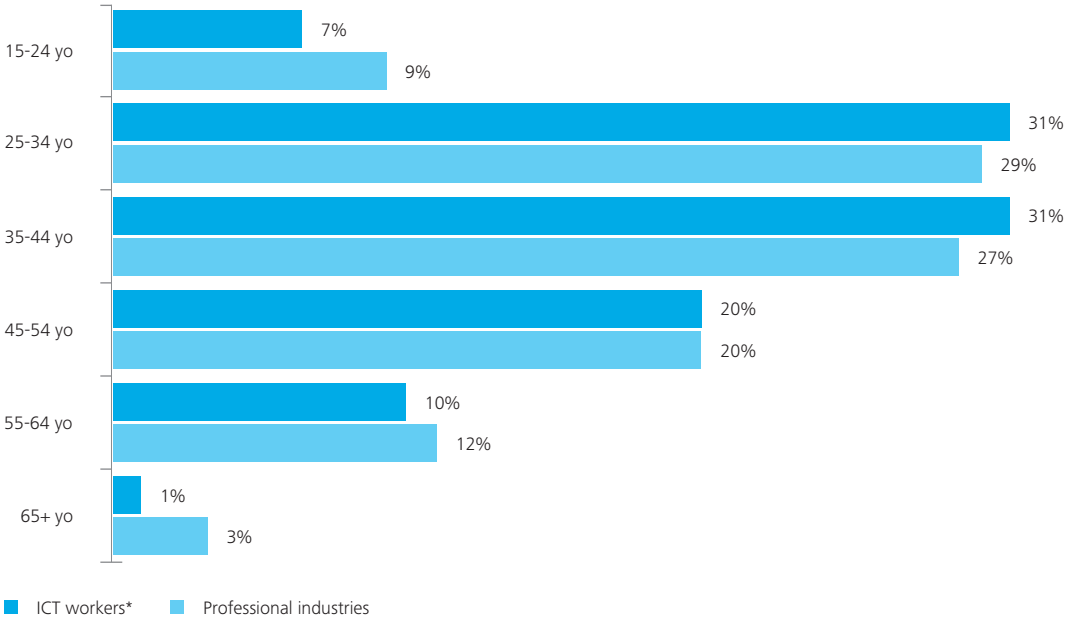
'IT job parity' and increasing the number of women in the ICT workforce was nominated as one of the key issues facing the industry in Deloitte's recent report on *Technology, Media and Telecommunications Predictions 2016.* The report suggested that improving female representation amongst ICT workers would require encouraging girls and young women to study science, technology, engineering and mathematics (STEM) subjects at primary, secondary and tertiary levels of education; depicting more positive female ICT role models in the media; and adjusting business practices relating to recruiting, retaining, paying and promoting employees so that these do not directly or indirectly discriminate against female ICT workers.

The ACS's 2015 report *The Promise of Diversity: Gender Equality in the ICT Profession* also highlighted the importance of female role models, leadership and culture, mentoring and flexible work practices in improving female participation in the ICT workforce. In addition, the report emphasised that young girls and women need to be encouraged to study ICT and computer science at the primary and secondary school levels. It recommended that a coalition of stakeholders (including industry, educators, employers, governments and career advisors) should be developed to increase female student engagement and promote ICT learning experiences and career opportunities to young girls and women within school educational settings.

1.3.2 Older ICT workers

There were around 62,000 ICT workers aged 55 years or older in 2015, representing 11% of the total ICT workforce. While older workers are slightly underrepresented in the ICT workforce compared to across all professional industries (15% of all workers), the age profiles are broadly similar overall (Chart 1.6).

Chart 1.6: Age profile of ICT workers, 2015



* 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 (2015)

Older workers make an important contribution in Australia's ICT workforce. In particular, they are highly represented in a number of more senior and specialised roles. For example, 26% of ICT trainers and 21% of telecommunications technical specialists are aged 55 years or over. This suggests that the skills and experience of older workers can be valuable in more high-level or specialised ICT positions.

Despite this, a number of studies have found that age discrimination against older workers is a concern in the ICT workforce. Skills obsolescence has been cited as a key reason for ageism in recruitment and retention decisions related to ICT workers, due to the perception that older workers have a more limited capacity to learn new skills (AWPA 2013).

Relatedly, the view that older workers possess outdated knowledge and qualifications has also been raised as an assumption made by companies and recruiters that could be contributing to ageist practices (ITCRA 2012). This perception impacts not only upon hiring practices in relation to ICT workers, but also across the broader workforce. In a world where digital technology is becoming increasingly prevalent in the workplace within many industries, the assumption that older workers may be slower to develop digital skills and familiarity with new technology could be contributing to age discrimination across the workforce. A national inquiry into age discrimination in the workplace is currently being conducted by the Age and Disability Discrimination Commissioner – for more details, refer to Box 1.3 below.

Box 1.3: Older workers in Australia's ICT workforce

The Australian Human Rights Commission is currently undertaking a National Inquiry into Employment Discrimination against Older Australians and Australians with Disability. The Inquiry is being conducted by the Age and Disability Discrimination Commissioner, the Hon. Susan Ryan AO, and will make recommendations as to actions that should be taken to address employment discrimination against older Australians and Australians with disability.

There were around 62,000 ICT workers aged 55 years or older in 2015, representing 11% of the total ICT workforce. Commissioner Ryan believes that improving the participation of older workers in the Australian workforce could lead to significant economic gains: "Some of the benefits associated with employing older workers include increased diversity in the workplace and the additional experiences and skills that such employees can bring to their job." This is particularly relevant for highly skilled roles such as ICT workers across management, operational and technical areas, where skills developed through previous employment and education experiences can be valuable.

Despite these benefits, the Commission has received individual complaints from and consulted with ICT workers who have faced age discrimination in relation to employment. Examples of age discrimination in the ICT workforce have also been reported more broadly in the media, with highly-skilled workers with decades of experience facing difficulties finding employment, because 'older people are too slow' (Papadakis 2016). This is consistent with the common misconception that older workers tend to face difficulties learning new skills – a perception that negatively affects not only older ICT workers, but also the broader workforce where employees are increasingly required to possess digital skills and familiarity with new technologies.

To address these issues and combat the stereotypes surrounding older workers, Commissioner Ryan believes that employers need to rethink their hiring approach by setting age aside and considering factors such as competence, performance and skills. In addition, there are a number of training and education opportunities available for reskilling or upskilling in ICT-related areas. Older workers should look to take up these opportunities where possible, and government could potentially look to provide financial support for older workers seeking to participate in such opportunities.

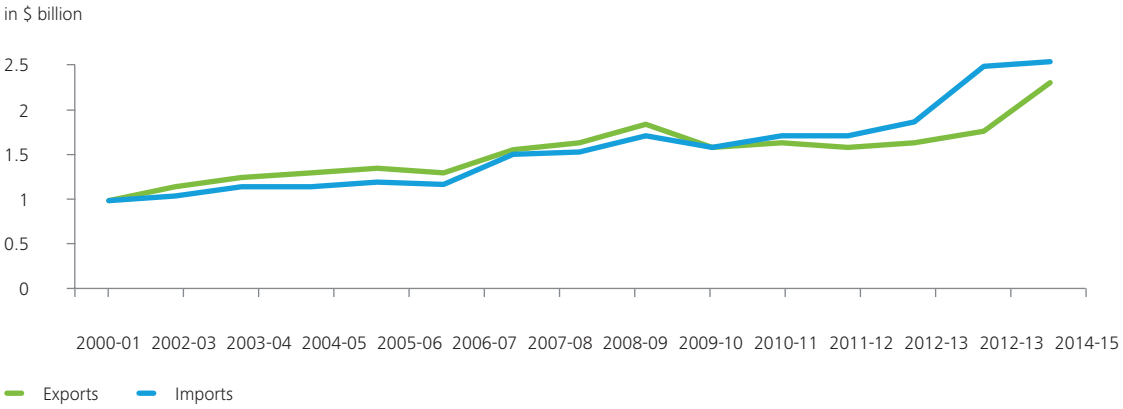
1.4 ICT business activity

Australian businesses' ICT activity has continued to increase. Trade flows in ICT services totalled almost $5 billion in 2014-15, with a particularly sharp rise in ICT services exports over the past year. Business expenditure on ICT research represents around one-third of total research and development expenditure, at around $6 billion.

Trade flows in ICT services have continued to increase, totalling almost $5 billion in the 2014-15 financial year. This included around $2.6 billion of ICT services imports and $2.3 billion of exports. ICT services trade is predominantly concentrated in computer services for both imports and exports, within which hardware and software consultancy services represent the largest share of trade flows.

While both imports and exports of ICT services have followed an increasing trend over the past decade, both have seen a sharp rise over the past couple of years. ICT services imports have increased by almost 40% between 2012-13 and 2014-15, and exports of ICT services rose by around 45% over the same period (Chart 1.7).

Chart 1.7: Trade in ICT services, FY2001 to FY2015



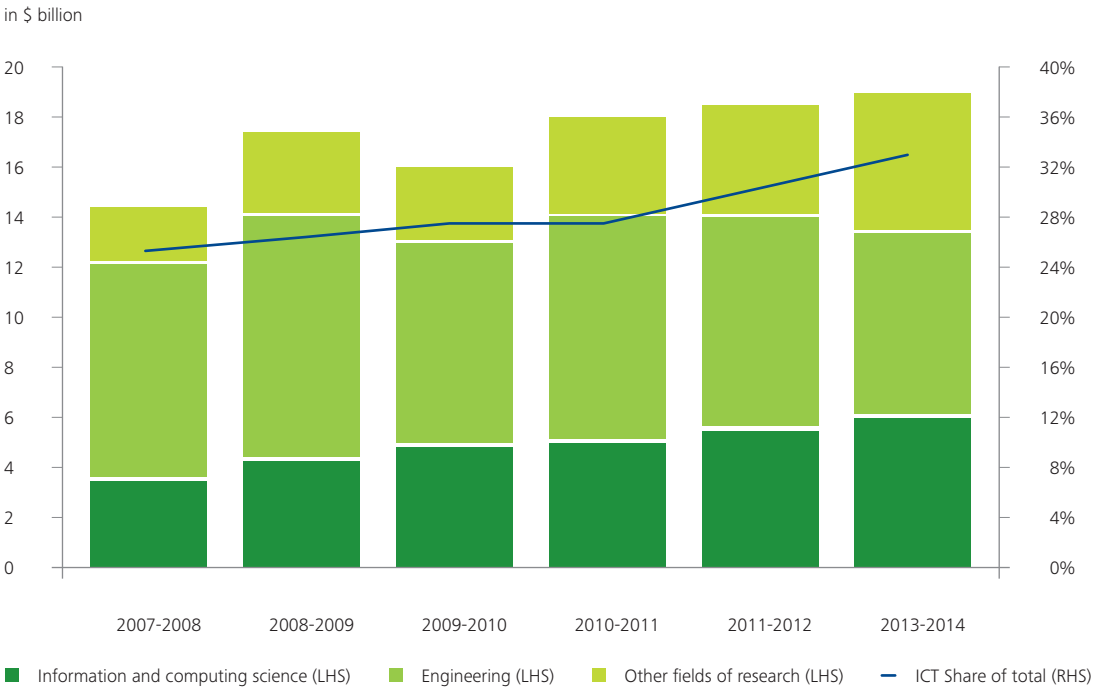
Source: ABS cat. 5302.0 (2015)

This is consistent with the increasingly globalised nature of the Australian economy, with the reduction of trade barriers around the world and technological advancements allowing companies to operate beyond country borders. These factors have facilitated increased connections and transactions at an international level, and this is reflected in the sharp rise in ICT services trade flows over recent years.

Importantly, the increase has occurred for trade in both directions – not only are overseas companies and workers increasingly involved in the provision of ICT services to Australia, but Australian companies and workers are also providing more ICT services to overseas countries. Other studies have suggested that this could reflect Australian organisations increasingly offshoring (importing) lower-end functions and services, while specialising in higher-value services that can then be exported to other countries (Chartered Accountants ANZ 2015). The sharp increase in ICT services exports over the past year could also reflect the impact of a lower Australian Dollar, which has depreciated significantly over recent years (RBA 2015), making it relatively cheaper for overseas individuals and companies to purchase Australian goods and services.

Australian businesses are also investing increasing amounts of funding into ICT research and development, spending more than $6 billion on this area in the 2013-14 financial year (Chart 1.8). This represented around one-third of total businesses' research and development expenditure, and this share has been steadily increasing over recent years.

Chart 1.8: Business research and development expenditure, FY2008 to FY2014



Source: ABS cat. 8104.0 (2015)

1.5 Migration of ICT workers

There was a net migration inflow of around 19,600 ICT workers in 2014-15, with software and applications programmers recording the largest net inflow of workers. Around 13,900 457 visas were granted to ICT workers over 2014-15, representing 15% of total visas but only around 2% of the overall ICT workforce in Australia.

There continues to be strong inflows of ICT workers into Australia, as Australian companies continue to use overseas workers to fulfil their ICT skills requirements. In the 2014-15 financial year, around 22,000 visitor arrivals were recorded for employment purposes amongst all ICT occupations. As there were only 2,300 departures of resident ICT workers for employment purposes, there was a net 'brain gain' of ICT skills totalling around 19,600 workers.

Similar to previous years, software and applications programmers recorded the largest net inflow of overseas workers in 2014-15, with a net migration inflow of around 5,300 workers (Table 1.1). The high demand for technical ICT skills such as programming is consistent with previous Deloitte research as reported in *Australia's STEM workforce: a survey of employers* (2014), which found that more than half of all employers of technology-qualified individuals rate programming skills as important in an employee.

Table 1.1: Net migration of ICT workers, FY2013 to FY2015

ICT occupation	2012-13	2013-14	2014-15
Software and applications programmers	5,212	5,152	5,324
ICT business and systems analysts	2,609	2,503	3,018
Management and organisation analysts	3,127	2,409	1,991
ICT managers	1,561	1,212	1,350
ICT sales professionals	1,112	1,260	1,347
Other information and organisation professionals	1,281	1,223	1,150
ICT support and test engineers	710	969	984
Graphic and web designers, and illustrators	728	631	823
ICT support technicians	708	670	602
Database and systems administrators, and ICT security specialists	672	610	579

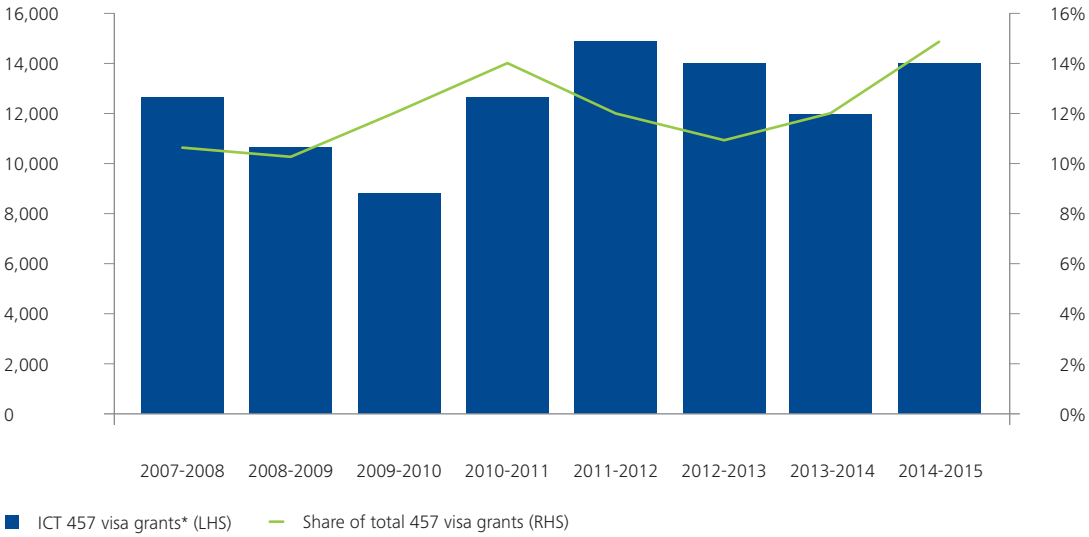
ICT occupation	2012-13	2013-14	2014-15
Other ICT occupations	2,800	2,470	2,474
Total ICT workers*	**20,520**	**19,109**	**19,642**

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

Source: Department of Immigration and Border Protection Overseas Arrivals and Departures Statistics (2016)

Immigration data suggests that the number and share of 457 visas – which allow skilled workers from overseas to work in Australia for a period of up to four years with approved Australian businesses – granted to ICT workers increased in the 2014-15 financial year. Around 13,900 457 visas were granted to ICT workers over 2014-15, representing 15% of total visas granted (Chart 1.9). However, this is a relatively small share of the overall ICT workforce, equivalent to around 2% of the 628,800 ICT workers currently employed in Australia.

Chart 1.9: Subclass 457 (temporary skilled work) visas granted to ICT workers, FY2008 to FY2015



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

Source: Department of Immigration and Border Protection Subclass 457 Visa Statistics (2016)

Despite these inflows of ICT workers from overseas, ICT occupations continue to feature prominently on state -specific occupation lists for skilled nominated migration programs. These lists catalogue the priority occupations that are eligible to be nominated for skilled migration programs in each state, and are determined based on the skills requirements of businesses within that state. In NSW, the latest state nomination occupation list features 12 ICT occupations, while the corresponding list in Victoria includes 11 ICT occupations (Table 1.2).

Table 1.2: ICT occupations on state nomination occupation lists for NSW and Victoria

NSW	Victoria
ICT business analyst	ICT project manager
Systems analyst	ICT business analyst
Analyst programmer	Systems analyst
Developer programmer	Analyst programmer
Software engineer	Developer programmer
Computer network and systems engineer	Software engineer
Telecommunications engineer	Software tester
Telecommunications network engineer	Software and applications programmers nec
Radio communications technician	Database administrator
Telecommunications field engineer	ICT security specialist
Telecommunications network planner	Computer network and systems engineer
Telecommunications technical officer or technologist	

Source: NSW Department of Industry Priority Skilled Occupation List (2016), Live in Victoria State Nomination Occupation List (2016)

1.6 ICT education in Australia

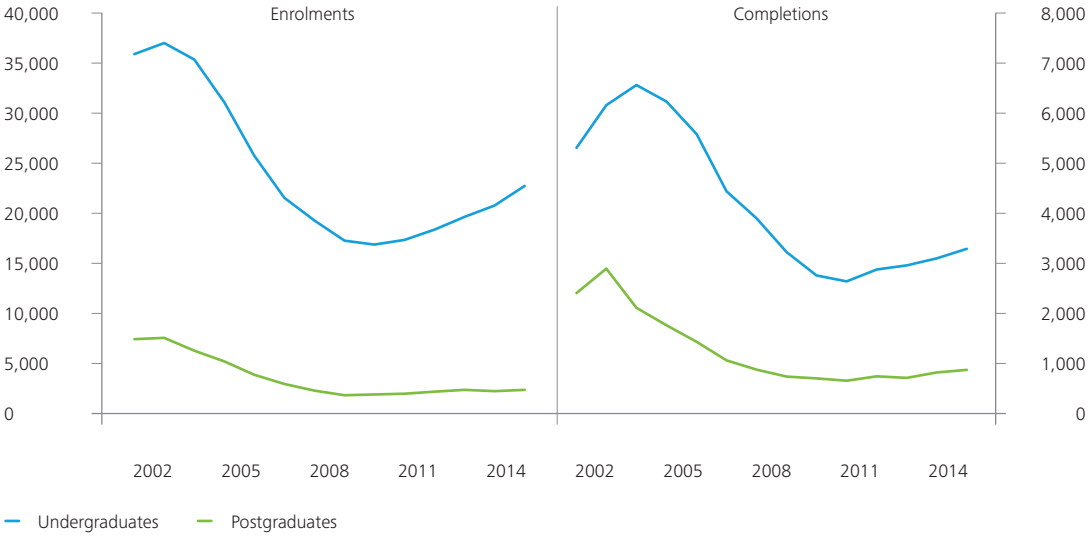
While ICT degree enrolments and completions remain below the peak of the early 2000s, they have gradually increased over recent years, with enrolments rising from 19,000 at the start of the decade to almost 24,000 in 2014. IT-related vocational education and training courses have also seen higher take up over the past few years.

Enrolments in and completions of ICT degrees at the tertiary level still remain well below the peak in enrolments seen in the early 2000s during the 'dot-com boom'. However, enrolment and completion rates have gradually picked up over recent years, with domestic undergraduate enrolments rising from around 19,000 at the start of the decade to almost 24,000 in 2014, and undergraduate completions increasing from around 3,000 to 3,600 over the same period (Chart 1.10).

Domestic enrolments and completions in postgraduate ICT degrees have also increased marginally, but continue to remain relatively low compared to levels seen in the early 2000s. This could pose a particular issue for the future ICT workforce, given that *Australia's Digital Pulse 2015* forecast that higher educational levels and qualifications will be associated with the strongest growth in future demand (for an update of this analysis, refer to Chapter 2).

As the number of people studying ICT degrees at a tertiary level slowly recovers, universities and businesses must work together to ensure that students are being appropriately educated in the digital skills that are relevant for today's workforce, and that they are able to develop the necessary experience to prepare them for future employment. The Office of the Chief Scientist recently found that while 73% of Australian IT students participate in industry-related projects, only a minority have access to longer term industry placements and workplace experiences (OCS 2015). The report called for a greater role for these types of work-integrated learning opportunities, to enable IT students to apply their learning, develop broader skills and enhance their career horizons and networks.

Chart 1.10: Domestic enrolments and completions of IT degrees, 2001 to 2014

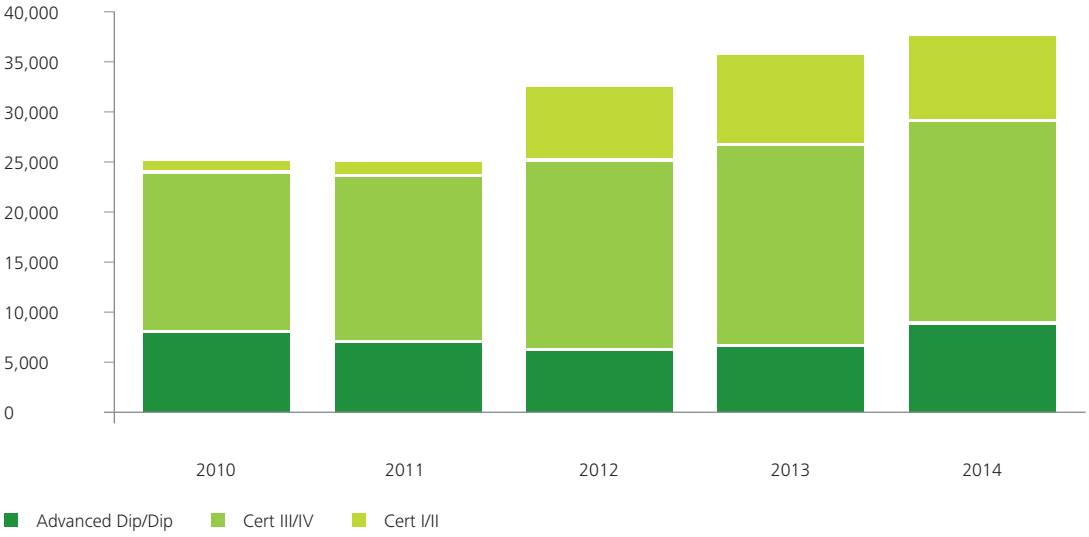


Source: Department of Education u-Cube (2016)

Enrolments in vocational education and training (VET) courses in the IT field of education have also increased over recent years, with around 37,000 students enrolled across Australia in 2014. An age breakdown of the VET students enrolled in IT courses in 2014 shows that almost half (47%) were aged 25 years or older. This suggests that a large share of VET students could be people who are already in the workforce that are seeking to upskill or reskill in technology-related areas.

The majority of VET students in IT courses are enrolled in Certificates, which are post-secondary qualifications that provide vocational skills to prepare students for employment or further education and training (Chart 1.11).[3] However, over the last year to 2014, almost all of the growth in VET enrolments for IT courses has been at the Diploma and Advanced Diploma level, which provide education and training in more advanced IT skills and knowledge.

Chart 1.11: VET enrolments in the IT field of education, 2010 to 2014



Source: National Centre for Vocational Education Research (2016)

3. The large increase in Certificate I enrolments in 2012 are in large part due to classification issues, as non-AQF (Australian Qualifications Framework) qualifications fell sharply at the same time, indicating that those qualifications may now be classified as a Certificate I level.

It should be acknowledged that ICT workers can be educated in other fields aside from directly studying IT and technology-specific tertiary or vocational qualifications. The 2011 Census reported that 65% of ICT workers studied non-IT degrees. More recently, LinkedIn data suggests that while computer science is the most common study area of ICT workers, another five of the top 10 are from business- and commerce-related fields of study (Table 1.3). This suggests that employers are able to draw ICT skills from other study areas as business and digital become increasingly integrated across the Australian economy.

Table 1.3: Most common areas studied by Australian ICT workers, 2015

1	Computer science
2	Information science and technology
3	Accounting
4	Business
5	Electrical engineering
6	Marketing
7	Business management and administration
8	Electronics
9	Software engineering
10	Project management

Source: LinkedIn customised report (2016)

2 Occupational analysis

This chapter considers the demand for ICT workers and qualifications in future years, using Deloitte Access Economics' workforce forecasting model. It also uses LinkedIn data to examine the types of ICT jobs that are available, the skills that ICT workers are required to possess and the digital skills that are in demand across the broader workforce.

Growth rates

2.0% p.a.

ICT workforce

1.5% p.a.

Broader workforce regularly using ICT skills

2015

628,810

ICT workforce

2,492,302

Broader workforce regularly using ICT skills

2020

695,364

ICT workforce

2,687,530

Broader workforce
regularly using ICT skills

2.1 Future demand for ICT workers

Australia's ICT workforce is forecast to rise from 628,800 workers in 2015 to 695,400 in 2020, representing an average annual growth rate of 2.0% (compared to 1.4% for the workforce as a whole). The strongest growth is expected for ICT management, operations, technical and professional workers. However, there are several potential risks that could impact upon these forecasts, including uncertainty surrounding global economic conditions and the impact of new technologies such as artificial intelligence.

2.1.1 Demand for workers

Consistent with our forecasts in *Australia's Digital Pulse 2015*, the outlook for employment of ICT workers is positive. Deloitte Access Economics forecasts that the number of ICT workers will increase from 628,800 in 2015 to 695,400 in 2020, at an annual average growth rate of 2.0%.

Since our 2015 report, Deloitte Access Economics has revised down longer term population growth in the Australian economy. As commodity prices have fallen substantially, this has engendered weaker wage growth and a lower Australian dollar and thus reduced the attractiveness of working in Australia as opposed to overseas. In turn, the downward revision to population growth has lowered the forecast productive capacity of the economy or what amounts to 'trend growth'. As a result, Deloitte Access Economics (like the Treasury and Reserve Bank) has downwardly revised growth forecasts for the economy and employment.

Consequently, the average annual employment growth rate forecast for the Australian ICT workforce between 2015 and 2020 (2.0%) is slightly lower than in the modelling done last year (2.2%).[4] However, the Australian workforce as a whole (including employees across all industries) is forecast to grow by an average rate of 1.4% under current forecasts as compared with 1.6% in our last report. In both reports, the ICT workforce was forecast to grow more quickly than the broader workforce to the tune of 0.6 percentage points. This reflects the expectation that employment prospects will be relatively strong for 'knowledge workers', and particularly workers who are significantly exposed to the rapidly growing digital economy.

Intuitively, as ICT gains greater prominence in traditionally non-ICT industries, ICT workers will be in demand to help facilitate this compositional shift. An example of this is Rio Tinto's autonomous trucks in the Pilbara, with core ICT skills in demand for the design process and the subsequent operation of an autonomous fleet with remote supervision (CEDA 2015). Michael Gollschewski, MD Pilbara Mines for the Iron Ore business of Rio Tinto, has stated that:

"As we move forward with automation systems, we will need specialists in computing, systems and diagnosis, and the upskilling of maintenance people to service and maintain the technology … To match the programming and analytical skills, we will need industry experienced and/or ready employees who can validate and interpret the data to challenge both operational and system behaviours."

4. Note that the forecasts presented in *Australia's Digital Pulse 2015* were provided from 2014 to 2020, for which the average annual growth rate was forecast to be 2.5%. The 2.2% growth rate reported above refers to the period from 2015 to 2020. (Employment from 2014 to 2015 was expected to – and consequently did – grow more strongly due to basing effects.)

This suggests that ICT workers are better placed than other workers (for example, the manual truck drivers or maintenance workers in the case of the example above) to cope with the disruptive forces in the jobs market relating to new digital technologies. Due to emerging digital trends such as the proliferation of big data, many roles are being created which did not previously exist. According to Monash University (2015), we have created 90% of the world's data in the last two years alone.

As Table 2.1 and Chart 2.1 show, employment growth is forecast to be strongest in the largest two ICT occupation groupings, ICT management and operations (2.3% average annual growth between 2015 and 2020, or 26,200 additional jobs) and ICT technical and professional (2.2% growth or 23,400 additional jobs). Together, these two occupation groupings are expected to comprise 75% of the total jobs growth forecast for the ICT workforce between 2015 and 2020.

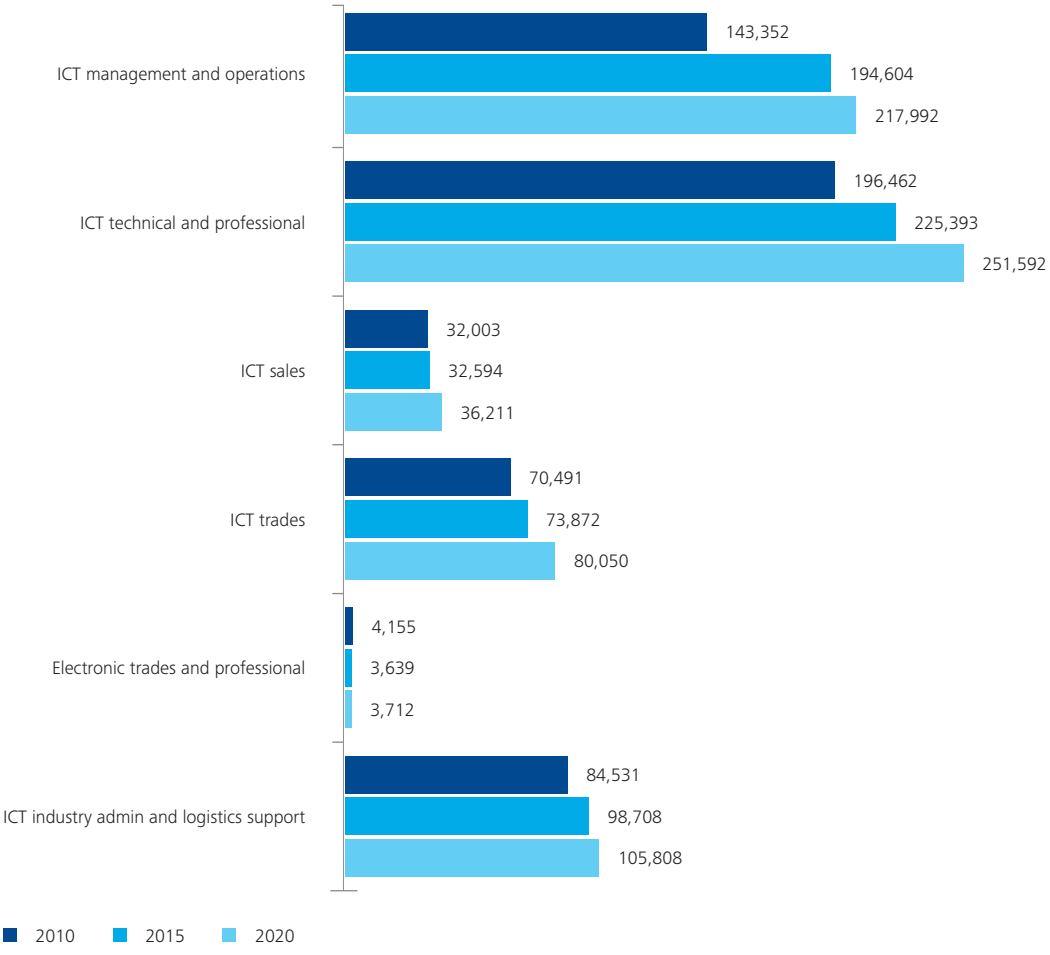
Table 2.1: Employment forecasts by CIIER occupation grouping, 2015 to 2020

	2015	2020	Average annual growth (2015-20)
ICT management and operations	194,604	217,992	2.3%
ICT technical and professional	225,393	251,592	2.2%
ICT sales	32,594	36,211	2.1%
ICT trades	73,872	80,050	1.6%
Electronic trades and professional*	3,639	3,712	0.4%
ICT industry admin and logistics support*	98,708	105,808	1.4%
Total ICT workers	**628,810**	**695,364**	**2.0%**

*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 (2016)

Chart 2.1: Historical and forecast ICT employment, 2010 to 2020



Source: Deloitte Access Economics (2016)

Workers in these two ICT occupation groupings are typically highly-skilled workers that are significantly exposed to – and in some cases, facilitating – the strongly growing digital economy. More generally, these types of workers are more likely to benefit from the longer-term trend of stronger growth in 'knowledge workers' roles as opposed to more manual 'blue collar' positions. The latter group of workers can be more vulnerable to automation, as they are more likely to involve non-cognitive tasks (for example, factory workers). While the cognitive tasks performed by 'knowledge workers' may also be impacted by automation (discussed below), to the extent that they involve social intelligence, creativity, perception or manipulation, workers are better shielded from being automated.

Growth in ICT sales workers is forecast to be relatively healthy (at an average rate of 2.0% between 2015 and 2020), benefitting from the growing digital economy as well as the fact that sales roles may be less threatened by automation or offshoring due to consumer preferences for 'face-to-face' interaction during the sales process. However, it should be noted that the increasing use of marketing automation and similar technologies designed to streamline and enhance sales and marketing processes could impact upon this occupation grouping.

Employment growth in ICT trades workers (1.6%) and admin and logistics support workers (1.4%) is more in-line with employment growth in the economy as a whole, while growth in electronic trades and professionals workers is expected to be soft at an average growth rate of 0.4%. Growth in this occupation grouping has historically been weak. Electronics trade workers may be seeing softer demand growth as the quality of the equipment they attend to improves, but also as digital disruption reduces the need for physical electronic equipment.

2.1.2 Demand for qualifications

The expected increase in demand for ICT workers implies that future demand for ICT qualifications and skills in the Australian economy will also increase. However, the demand for qualifications depends not only on the above employment forecasts, but also on other skills and labour market considerations, such as the propensity for different occupations to hold certain education levels.

As shown in Table 2.2, total qualifications held by ICT workers are forecast to increase from 995,600 in 2015 to 1,157,000 in 2020, at an annual average growth rate of 3.1%. This rate of growth exceeds the forecast employment growth rate over the same period, pointing to the increasing propensity for workers to hold more than one qualification ('skills broadening') and to hold higher levels of qualifications ('skills deepening').

Table 2.2: Total qualifications held by ICT workers, 2015 to 2020*

	2015	2020	Average annual growth (2015-20)
Postgraduate	209,810	247,786	2.9%
Undergraduate	418,248	484,259	3.0%
Advanced diploma/diploma	176,540	198,851	2.4%
Certificate III and IV	127,364	152,176	3.6%
Certificate I and II	63,616	73,963	3.1%
Total	**995,578**	**1,157,035**	**3.1%**

* One person may hold multiple qualifications

Source: Deloitte Access Economics (2016)

Note that Table 2.2 refers to total qualifications – a stock of qualifications held by the current workforce. This stock of qualifications is projected to increase over time, but the additional qualifications required will be more than just the change in the stock. There will also be additional qualifications required as different individuals move in and out of ICT occupations – notably as some workers retire and are replaced by new entrants to the workforce.

Despite the long term historical trend towards skills deepening, ABS statistics suggest that the propensity for workers to hold postgraduate qualifications has increased at such a significant rate in recent years that Deloitte's modelling forecasts slightly less robust growth in postgraduate qualifications over the next five years. As such, postgraduate qualifications for ICT workers are forecast to increase at 2.9% over the next five years, marginally below the rate of total growth in qualifications. Growth in undergraduate qualifications is expected to be similar, at 3.0% average annual growth over the next five years. Growth in advanced diplomas or diplomas is expected to be marginally weaker at 2.4%.

The strongest growth in demand for qualifications for ICT workers from 2015 to 2020 is forecast to come from Certificate III/IV qualifications. This may reflect the fluid nature of skills needs in the ICT workforce and the benefits of obtaining relevant Certificate III/IV qualifications. This indicates that skills broadening is likely to be the dominant story here, as workers with an undergraduate degree may look for a more practical or specialised form of Certificate III/IV training. For the lower Certificate I/II qualifications, skills demand is expected to grow by an annual average rate of 3.1% over the next five years.

2.1.3 Risks and uncertainties

In considering the employment outlook for ICT workers over the next five years, the above analysis represents Deloitte Access Economics' 'base case'. However, there are a range of potential risks and uncertainties that may impact upon these employment forecasts. Some of the key risks are discussed below.

Global economic conditions

The current global economic picture is a cloudy one as we enter 2016. China's economy is slowing, despite being a key locomotive of global economic growth after the global financial crisis. The country's economic strategy, which relied upon very high levels of investment in real estate and public infrastructure (particularly following the financial crisis), has run into trouble. Some of this industrial investment has become uneconomic and this has given rise to significant concerns around debt and overcapacity in the country. According to McKinsey Global Institute (2015), China's debt increased almost four-fold between 2007 and the second quarter of 2014, from $7.4 trillion to $28.2 trillion.

As a result, China's policymakers are seeking to transition China's economic growth model to a more services-based, consumer-led model. However, this transition is far from smooth, with some excess investment to work off and a legacy of potential bad debts. In turn, China's rebalancing poses problems for Australia, as a large commodity exporter to China. A 'hard landing' for China's economy would increase the likelihood of an economic downturn in Australia, while a credit crunch in China could spell trouble for the global economy. Furthermore, key central banks around the world are still at emergency-low interest rate settings, raising questions over the ability of monetary policy to combat any slowdown.

Needless to say, a slowdown in the Chinese economy that leads to an economic downturn or recession in Australia would pose a downside risk to employment in the ICT sector – recession, of course, poses employment risks to most industries. Several years ago, the OECD examined how ICT employment performed in the US after the 'tech-wreck' in the early 2000s and the global financial crisis in 2008-09. ICT employment performed better in the latter as ICT was more 'collateral damage' rather than an integral part of the downturn, as it was in the bursting of tech bubble in the 2000s (OECD 2012). Nonetheless, employment in both ICT services and ICT manufacturing contracted in the aftermath of the global financial crisis, respectively declining by 4% and 10%.

As such, a significant global economic downturn – if it were to eventuate before 2020 – has the potential to undercut the ICT employment forecasts presented above. The US experiences discussed above suggest that there may be a larger fall in ICT manufacturing roles (more closely aligned with the ICT trades and electronics trades occupation groupings) rather than ICT services roles (which would likely be aligned with the ICT technical, professional, management and operations occupation groupings).

Proliferation of digital technologies

Another scenario which may affect the above employment forecasts comes from higher productivity growth due to the potential for increased uptake of new and emerging digital technologies such as mobile internet, big data and data analytics, the Internet of Things, and artificial intelligence and machine learning. While Deloitte Access Economics has taken productivity trends into account as part of the employment forecasting process, there is a possibility that productivity growth may exceed that which is assumed due to the rapid nature of technological advancements and the impact that this might have on the Australian economy.

Broadly, the economy would be expected to be better off due to higher productivity allowing for a higher potential level of output. In turn, the income freed up through more efficient production processes would be expected to circulate through the economy and create demand in other areas, indirectly leading to increased employment.

However, the direct impact on employment would be more nuanced. As canvassed, while this scenario would see some automation of jobs due to new labour-saving digital technologies, there would also be employment opportunities for those designing, implementing and monitoring the technologies. The net impact on ICT employment in the future is therefore uncertain – while the ICT workforce has thus far been a strong net beneficiary of technological change and it might therefore be expected to continue to gain from future digital disruption, ICT employment may also face its own threats from computerisation. This was noted by Frey and Osborne (2013), using examples such as the increasing use of algorithms to automatically detect bugs in software.

Within the ICT workforce, under this scenario of increased proliferation of digital technologies, highly-skilled knowledge workers may be expected to fare better than those in more manual roles. As a result, this scenario may be expected to widen the existing disparity in expected employment growth between ICT technical, professional, management and operations workers (higher growth) and ICT trades, industry admin and logistics support workers (lower growth). This is consistent with research in the area which has found wages and educational attainment exhibit a strong negative relationship with an occupation's probability of computerisation (Frey and Osborne 2013).

2.2 What ICT jobs are available?

The ICT jobs that are currently in high demand include a mix of technical and business-related roles, with several of the most in-demand occupations reflecting emerging areas such as cloud computing and cyber security. ICT workers are increasingly required to have broader skills – such as relationship management, customer service, strategic planning and contract negotiation – as technology becomes more integrated with the wider business.

To provide some insights on where the demand for ICT jobs and skills currently lies in the economy, we have examined data from LinkedIn on employer demand for ICT-related occupations based on job advertisements and recruiting activity on the online LinkedIn platform.

This data allows us to assess the areas where companies are demanding ICT skills and what opportunities are available to ICT workers – in real time and to a high level of detail. The use of such data allows for a more up-to-date assessment of where the current and new demand for ICT jobs is. In addition, the LinkedIn data provides a higher degree of granularity around the skills that workers possess and employers demand, as compared with traditional data sources that generally only capture information on formal qualifications. The timeliness and granularity associated with the LinkedIn data is valuable particularly when analysing ICT workers and skills, as ongoing technological advancements mean that the ICT-related occupations and roles are constantly changing.

However, a caveat associated with the LinkedIn data is that it is based on the data entered into the website by members. As such, the data is influenced by how members choose to use the site, which can vary based on professional, social and regional culture, as well as overall site availability and accessibility. For example, LinkedIn users tend to be professional or knowledge workers and the data is therefore likely to be skewed towards office-related jobs and skills rather than, for example, builders or chefs. These variances have not been accounted for in the analysis that follows.

The LinkedIn data classifies 100 occupations as ICT roles, including a range of developer, engineer and consultant positions spanning both technical and business-related areas. Figure 2.1 presents a word cloud of some of the most frequently used words referenced in the job titles of these ICT roles. In addition, more than 1,200 skills are categorised as ICT and digital skills in the LinkedIn database – Figure 2.2 depicts a word cloud corresponding to these skills.[5]

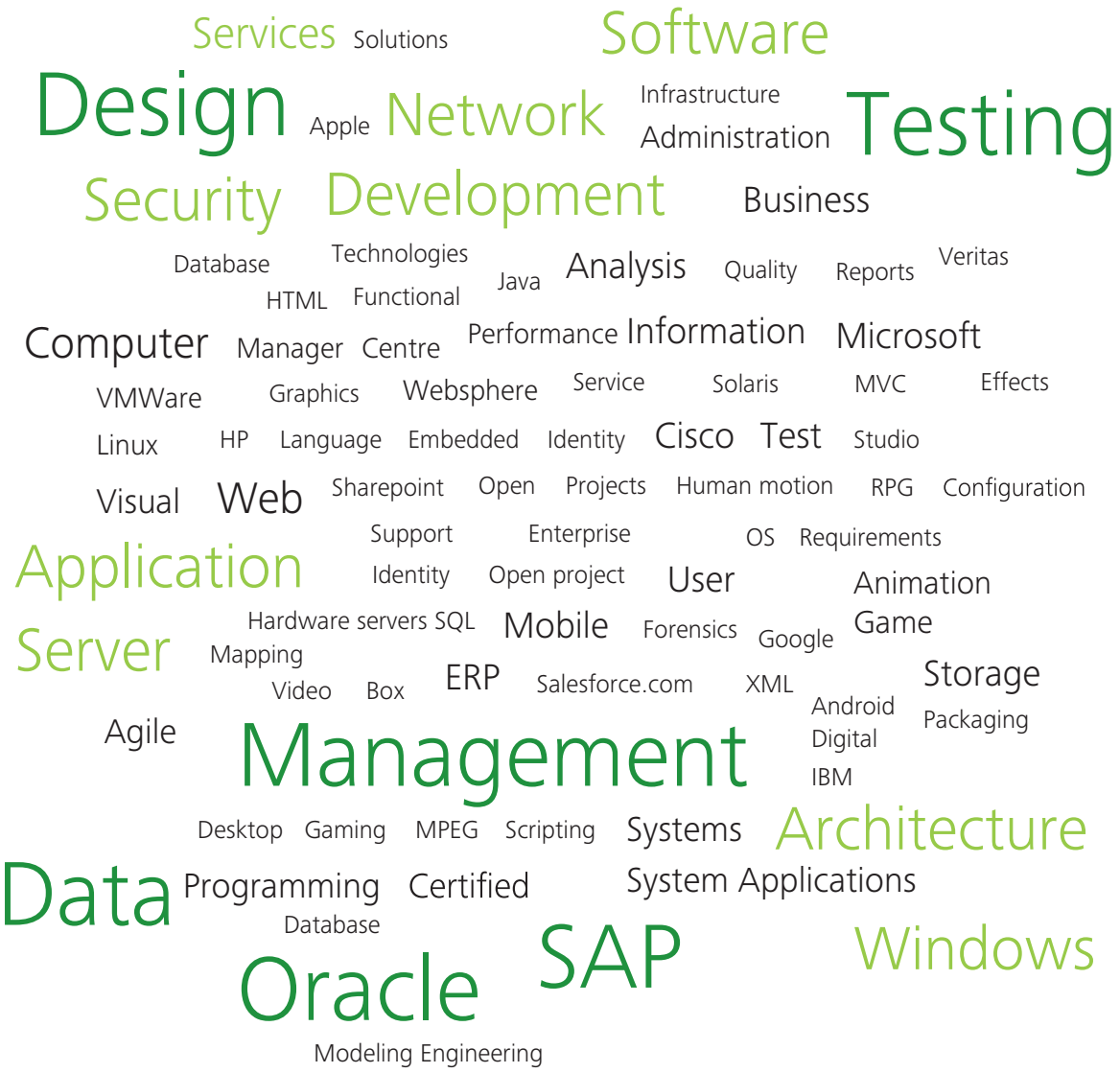
5. Note that the LinkedIn data includes both ICT and digital skills, and as such these terms have been used interchangeably throughout the discussion.

Figure 2.1: ICT occupations on LinkedIn – word cloud*

* Larger text indicates more frequently referenced words

Source: LinkedIn customised report (2016)

Figure 2.2: ICT skills on LinkedIn – word cloud*



* Larger text indicates more frequently referenced words

Source: LinkedIn customised report (2016)

An analysis of the ICT occupations with the largest number of job advertisements on LinkedIn in Australia in 2015 shows that there is a mix of both technical roles and business-related roles that are in high demand (Table 2.3). This first category includes occupations that require a high level of core technical ICT skills such as software engineer, software developer and technical consultant. The latter includes occupations that connect these technical roles to broader business requirements, such as business development manager, business analyst and project manager. The significant demand for these types of roles is consistent with the increasing integration of ICT uses and functions with broader business operations.

Table 2.3: ICT occupations with the most job advertisements, 2015

1	Technical Consultant
2	Business Development Manager
3	OpenStack Java/AMQP Developer
4	Project Manager
5	Senior Account Manager
6	Security Consultant - Network Security
7	Business Analyst
8	Software Engineer
9	Freelance: Foreign Language Content Contributor
10	Software Developer

Source: LinkedIn customised report (2016)

Several roles in the top 10 list of ICT occupations with the most LinkedIn job advertisements reflect areas that have only emerged over recent years. For example, the OpenStack Java/AMQP developer role relates to cloud computing development work. As the use of cloud computing increases in companies across a range of industries in the Australian economy, demand for ICT workers with cloud-related skills is also rising. The move towards cloud solutions is opening up new opportunities for ICT workers who are able to transfer their existing skills or develop new skills specific to developing, configuring, operating and supporting cloud-related technologies.

The cyber security area has also seen increasing demand for skills and workers over recent years, with network security consultant featuring in the top 10 list. In 2015, the National Innovation and Science Agenda included a proposal to establish a Cyber Security Growth Centre, in order to facilitate national action on innovation, skills and collaboration on cyber security issues. For more details about the growing focus on ICT security both in Australia and globally, see Box 2.1.

Box 2.1: Cyber security – a growing area in ICT

In today's interconnected digital world, an increasing amount of activity is being conducted online, from personal banking to government infrastructure to business transactions. As such, cyber risk is now at the top of the international agenda, as high-profile security breaches raise concerns around the potential impact on the global economy.

The World Economic Forum's *Global Risks 2015* report highlighted cyber attacks and threats as one of the most likely high-impact risks. In the United States, for example, cyber crime already costs an estimated $100 billion a year, and it has a growing potential to inflict significant economic damage as global interconnectedness and use of digital infrastructure continues to rise (WEF 2015).

In Australia, cyber security is becoming an increasingly significant focus for companies of all sizes and across all industries. The Department of Communications has reported that the average cost of a cyber crime attack to a business is around $276,000 (Australian Government 2015). CERT Australia, the national computer emergency response team and a partner agency in the Canberra-based Australian Cyber Security Centre, responded to almost 12,000 cyber crime incidents in 2014-15.

In light of this, Australian businesses are recognising the importance of protecting their ICT infrastructure from security threats and the benefits associated with securing their systems and information. Network security consultants were the sixth most advertised ICT occupation on LinkedIn in 2015, and data from SEEK suggests that the number of cyber security roles advertised in Australia grew by more than 60% in 2015 (Lui 2015).

Recognising the importance of cyber security and global cooperation on cyber threats, Prime Minister Malcolm Turnbull recently announced a new cyber security dialogue to be held annually between Australia and the United States (Turnbull 2016). The dialogue will engage business, academic and government representatives from both countries to discuss common cyber threats, promote cyber security innovation and shape new business opportunities.

Box 2.2 below features a case study on the Commonwealth Bank of Australia, with insights on the growing emphasis within the company on its cyber security practice.

Box 2.2: Commonwealth Bank of Australia

The Commonwealth Bank of Australia (CBA) is one of the 'big four' Australian banks, providing a variety of financial services including retail, business and institutional banking; funds management and superannuation; and investment and broking services. The company has significant digital requirements and employs a large ICT workforce to meet these needs.

A growing area within CBA's ICT workforce is the cyber security practice. This is because the company recognises that the digital transformation of the Australian economy must be supported by a strong foundation of cyber security, in order to engender confidence in digital interactions and transactions. As such, cyber security has been an area of considerable investment for CBA, and digital trust and the provision of secure financial services is viewed as a key market-facing proposition rather than simply a compliance issue.

Cyber security involves a broad spectrum of ICT skills and roles. At CBA, this includes cyber threat intelligence to assess what their adversaries are doing; incidence response to manage how they respond to security breaches; digital forensics which requires the unique combination of computer science and law; and web application assurance to act out attacks on their systems. However, it can be difficult to hire workers with the right skills in these areas. In particular, graduates from computer science courses often lack the applied skills that are relevant to the modern cyber security practice, such as malware analysis and web applications testing.

In light of these challenges, CBA has recently announced a Security Engineering Partnership with the University of New South Wales (UNSW), pledging $1.6 million to develop a centre of excellence for cyber security research and teaching. The initiative is aimed at boosting the nation's expertise in quality security engineering, by creating a new cyber security undergraduate curriculum and a Security Engineering Lab for hands-on teaching of security courses. It is hoped that the partnership will help to improve Australia's broader cyber security capabilities and support the growing digital economy in future years.

Another question that could be asked is – what companies and industries are employing these ICT workers and skills? As discussed in Section 1.3, around half of the current ICT workforce in Australia is employed outside of ICT-related industries. This is also reflected in the hiring intentions of companies posting job advertisements on LinkedIn, with 9 of the top 20 industries with the largest amount of ICT job advertisements (as a share of total job advertisements) being non-ICT industries. These include a variety of sectors in the Australian economy such as finance, government, health and education (Table 2.4).

Table 2.4: Industries with the largest share of ICT job advertisements, 2015

1	Information technology and services	11	E-learning
2	Computer software	12	Financial services
3	Internet	13	Human resources
4	Electrical and electronic manufacturing	14	Computer games
5	Information services	15	Telecommunications
6	Staffing and recruiting	16	Military
7	Computer hardware	17	Banking
8	Computer and network security	18	Government administration
9	Consumer electronics	19	Accounting
10	Computer networking	20	Hospital & health care

Source: LinkedIn customised report (2016)

Employers that are hiring ICT workers are demanding a range of technology-related skills. However, in addition to these ICT-specific skills, LinkedIn data highlights the fact that businesses are increasingly demanding that their ICT workers possess broader and more general skills. Analysis of the skills possessed by ICT workers who have recently moved jobs in the LinkedIn database shows that 8 of the top 20 skills (including 6 of the top 10) are broader than core technical ICT skills (Table 2.5). These include skills such as relationship management, customer service, strategic planning and contract negotiation – many of which could be transferrable from other occupations and industries.

Table 2.5: Top 20 skills possessed by ICT workers moving jobs, 2015

1	Process and Project Management	11	Microsoft Windows Systems
2	IT Infrastructure and System Management	12	Middleware and Integration Software
3	Management Consulting, Business Strategy and Analysis	13	Purchasing and Contract Negotiation
4	Database Management and Software	14	Computer Network and Network Administration
5	Business Development and Relationship Management	15	Cloud and Distributed Computing
6	Software Engineering Management and Requirements Gathering	16	Software and User Testing
7	Web Programming	17	Graphical Design
8	Strategy and Strategic Planning	18	Mac, Linux and Unix Systems
9	Sales	19	Social Media Marketing
10	Customer Service	20	Account Management

Source: LinkedIn customised report (2016)

This reflects the increasing integration of ICT in core business functions, and the importance for ICT workers to consider the broader business implications associated with technological use and change. The ICT workforce no longer operates as a silo, and it is now important that ICT workers are able to communicate on complex technical issues and the impact that these could have on the business. Of particular note is the fact that many of the more general capabilities highlighted above require workers within technological functions to have good 'soft skills', such as communication and presentation skills.

2.3 Broader workforce ICT skills requirements

The broader workforce is increasingly required to have digital skills as technology becomes more ubiquitous in everyday processes and operations. The number of workers who use ICT regularly as a part of their jobs is forecast to increase from around 2.5 million in 2015 to almost 2.7 million in 2020. Relevant ICT skills for the broader workforce include business-related ICT capabilities such as requirements analysis, technical ICT skills that could be useful for non-ICT workers such as SQL, and the use of common types of office software such as Windows and SAP.

In today's workforce, basic digital skills are quickly becoming assumed knowledge, particularly in professional occupations. This essential level of digital literacy includes skills such as using common software packages like Microsoft Office and the ability to use search engines for research purposes. Over recent years, these digital skills requirements have been rising in importance in the broader workforce as technology has become increasingly integrated with jobs and tasks across a range of industries.

In the OECD's *Digital Economy Outlook 2015*, it was stated that:

"The convergence of fixed, mobile and broadcast networks, along with the combined use of machine-to-machine (M2M) communication, the cloud, data analytics, sensors, actuators and people, is paving the way for machine learning, remote control and autonomous machines and systems. Devices and objects are becomingly increasingly connected to the Internet of Things, leading to convergence between ICTs and the economy on a grand scale."

Disruptive technologies are breaking down traditional industry distinctions and ICT is becoming increasingly fused into the broader economy across many sectors that have not traditionally been large users of ICT. As a result of this, digital skills are becoming increasingly necessary in the broader workforce.

An example of this is in the accounting industry. The accounting field of study and occupation is not traditionally one that has been aligned with the ICT industry, and historically accountants performed their jobs without computers. However, the increasing use of technology in the accounting profession means that accountants now must possess skills in accounting software, word processing and presentations, information systems and databases, e-commerce and potentially a number of other digital skills. Newer accounting software and services such as the cloud-based Xero mean that accountants need to continually develop their ICT skills in order to remain up to date with the latest technological developments.

The increasing digitisation of many jobs in the broader workforce can be observed across the Australian economy. In many cases, the rising use of digital technology in industries and occupations outside of the ICT sector has been associated with the development of more user-friendly software and applications that only require a basic understanding of ICT to use, rather than needing a deep knowledge of technical ICT skills. This leads to digital skills being required across a broader base of occupations – for example, Box 2.3 explores the case of the South Australian Government and the increasing ICT skills requirements within its workforce.

Box 2.3: South Australian Government

The South Australian (SA) State Government employs the largest ICT workforce in the state, with around 1,570 ICT professionals and a further 400 employees embedded within business functions whose roles are significantly geared towards ICT services and support.

Digital technology is a significant focus of the SA public service. In November 2014, the Premier signed a *Digital by Default Declaration* pledging that new or reformed government services will be digital by default, such as being available online and mobile-ready. Following this, a number of initiatives are already underway, such as moving some drivers licence and vehicle registration tasks online and implementing self-service kiosks at Service SA centres.

One trend that is emerging in the SA Government's workforce is that basic ICT tasks are increasingly being performed by workers in the broader workforce, rather than by ICT specialists. This change has been facilitated by technological developments such as cloud computing and more user-friendly software applications. For example, where gathering data to create an output that provides meaningful insights previously may have required a database administrator to write an SQL query to extract and configure the data, the process can now be done by workers without technical ICT skills using data visualisation software such as Tableau or Microsoft BI.

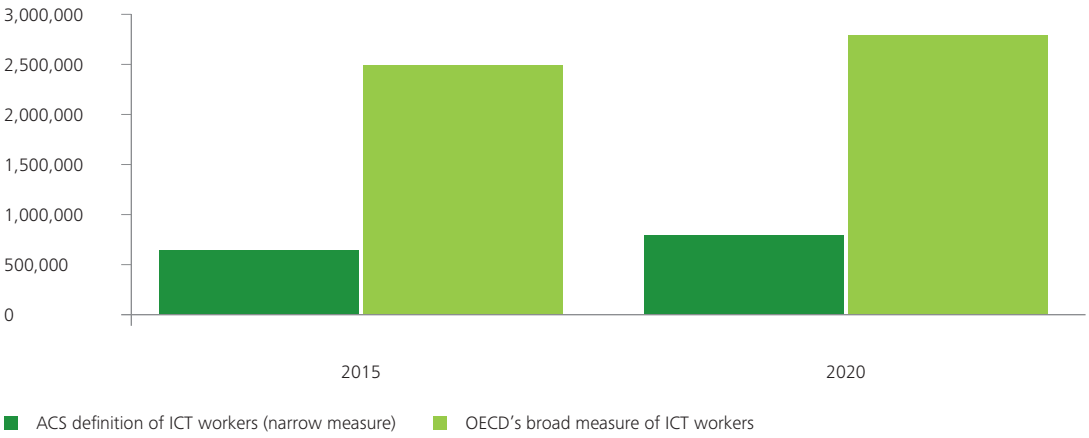
These changes mean that it is increasingly important that the broader SA public service has the required skills to be able to work with these new technologies. The SA Office for Digital Government is currently conducting a training needs analysis across the entire public service to create a common framework of competencies and capabilities in digital and ICT skills. This will assist agencies on identifying skills gaps and planning their workforce development and digital strategies.

In the context of the increasing pervasiveness of ICT skills across the broader workforce, the OECD has created two definitions associated with ICT workers: a 'narrow' measure and a 'broad' measure (OECD 2012). The narrow measure represents ICT specialists who develop, operate and maintain ICT systems, with ICT constituting the main part of their job. This definition corresponds closely with (though is not identical to) the definition used for this report and the 628,000 ICT workers we have estimated to be in the Australian economy.

The broader measure includes employees who use ICT regularly as a part of their jobs and rely on ICT skills to perform their work, but whose jobs do not focus on ICT. This includes a number of occupations including accountants, solicitors, architects and environmental scientists (a full list of occupations including in this definition is contained in Table A.4).

Using the OECD's broader measure of ICT workers, Chart 2.2 illustrates the size of the narrow and broad ICT workforce in Australia and their projected growth to 2020. There were 2,492,300 workers in the Australian labour force classified as part of the broad measure of ICT workers in 2015. Deloitte Access Economics forecasts that this will grow by an annual average rate of 1.5% over the next five years to 2,687,500 workers in 2020, equivalent to a projected gain of 195,200 jobs over this period.

Chart 2.2: ICT workforce growth under narrow and broad measures, 2015 to 2020



Source: Deloitte Access Economics (2016), OECD (2012)

While the number of jobs is forecast to increase, two additional factors should be noted in relation to the digital skills requirements of the broader workforce in future years:

- The ICT intensity of jobs under the broader measure of ICT workers is likely to increase in the future. That is, occupations that are currently classified as regularly using ICT as part of their jobs are likely to rely increasingly on digital technology as new developments emerge and are integrated into businesses' products, operations and processes.
- The boundaries between the occupations that use ICT regularly and those that do not are likely to shift. Given the rate of change in the digital economy and the rapid pace of technological advancement, the categorisation of occupations has likely changed since the broad measure was defined in 2012, and will continue to evolve over future years. As such, an increasing number of occupations will be classified as regularly using ICT.

The specific ICT skills required of this broader measure of workers who are regular users of ICT in their jobs can be varied. As discussed in Box 2.4, LinkedIn data suggests that these skills include business-related ICT capabilities, technical ICT skills that could be useful for non-ICT workers and the use of common types of office ICT and software.

Box 2.4: Top ICT skills possessed by workers in non-ICT occupations

As part of the analysis on the digital skills required amongst the broader workforce in Australia, we have examined LinkedIn data on the ICT skills possessed by workers in non-ICT occupations in 2015. The data suggests that a number of different types of ICT skills may be required across the broader workforce.

The top 10 list of ICT skills possessed by workers in non-ICT occupations can be found in the table below. They include:

- Skills relating to integrating ICT with the rest of the business such as business analysis, requirements analysis and strategy;
- Technical skills that could be useful for non-ICT workers such as SQL for data analysis and IT infrastructure library (ITIL) skills to understand how systems operate; and
- Use of specific types of software that are commonplace in many office environments such as Windows and SAP.

1	Business Analysis
2	Integration
3	Requirements Analysis
4	ITIL (IT infrastructure library)
5	SQL
6	SDLC (software development lifecycle)
7	IT Strategy
8	Windows
9	Solution Architecture
10	SAP

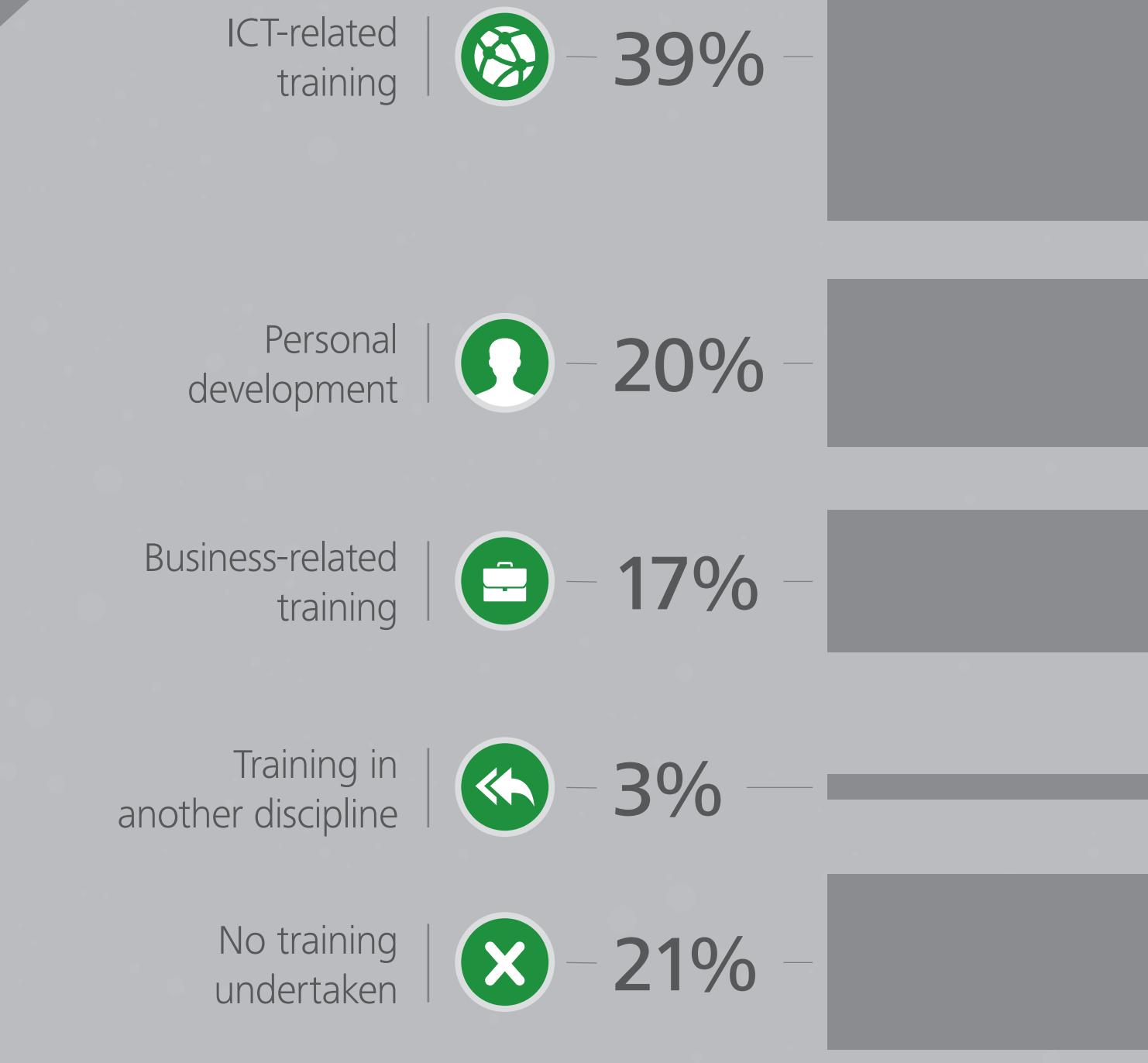
Source: LinkedIn customised report (2016)

The wide-ranging nature of this list of skills suggests that the ICT skills required of the broader workforce can vary depending on the specific job role. It is important that employees are aware of the ICT skills necessary in their position, and that they work to develop these skills. This is particularly the case because businesses are likely to increasingly demand some level of ICT knowledge and literacy when hiring new workers as technology becomes more ubiquitous in everyday processes and operations.

3 Workforce planning and development

This chapter discusses the importance of ICT skills development across the Australian workforce. It considers how companies can assess the ICT skills required for their business and the training and learning opportunities that are available to workers seeking to upskill or reskill in ICT-related areas.

Training undertaken in last 12 months by survey respondents


ICT-related training
39%
Personal development
20%
Business-related training
17%
Training in another discipline
3%
No training undertaken
21%

3.1 The case for ICT workforce and skills development

As ICT university graduates represent only 1% of current ICT workers each year, our greatest resource for developing the ICT skills required in a growing digital economy is the current workforce. Business investment in workforce learning and development can have a number of benefits compared to 'buying skills' through external hires: existing workers can be trained in the specific skills required by the business, and are more easily able to apply new training given they have more experience at the company.

3.1.1 Supplying the Australian workforce with ICT skills

In the long term, ensuring that Australia's workforce has a sustainable supply of ICT workers and skills requires increasing the number of Australian students studying ICT-related subjects and courses at the primary, secondary, university and vocational levels of education. Given the critical role that ICT education has to play in improving the domestic pipeline of ICT workers both now and in the future, the 2015 edition of *Australia's Digital Pulse* included a special chapter on ICT education in Australia. Since the report was released, there has been considerable policy action in this area – Box 3.1 describes some of the progress that was made over 2015 on developing ICT education in Australian schools.

Box 3.1: ICT education in schools – progress over 2015

The 2015 edition of *Australia's Digital Pulse* highlighted that governments and schools around Australia should increase their focus on equipping students with the digital and computing skills that will be required of our future workforce. This included accelerating the development and implementation of the Technologies component of the Australian Curriculum.

Since then, there have been a number of policy announcements in this area. In December 2015, Prime Minister Malcolm Turnbull announced a National Innovation and Science Agenda, which included a $51 million investment in measures to support Australian school students to create and use digital technologies (Australian Government 2015). These included online computing challenges for Years 5 and 7 students, targeted ICT programmes such as ICT summer schools for Year 9 and 10 students, and support for upskilling teachers to implement the Digital Technologies curriculum. Opposition Leader Bill Shorten has also committed to ensuring that computer coding is taught across Australian Schools (Shorten 2015).

In addition, State Governments have taken further steps with regards to introducing coding in classrooms. In Queensland, Premier Annastacia Palaszczuk has pledged that every state school will offer the Digital Technologies curriculum from Prep to Year 10 as of 2016, in order to prepare students for the jobs of the future by embracing new technologies (Palaszczuk 2015). A number of states and territories – such as South Australia, Victoria and the ACT – are planning to implement the curriculum over 2016 and 2017, having trialled it in 2015 (ACARA 2015). Other states are also looking for ways to incorporate the curriculum amongst schools in their jurisdictions.

However, it is important that the Australian workforce is not wholly reliant on the pipeline of ICT students and graduates as the sole domestic source of ICT workers and skills to support the growing digital economy.

Compared to the size of the existing ICT workforce, the number of students completing further study in ICT is relatively small, with the 5,100 completions of undergraduate and postgraduate ICT degrees in 2014 representing only 1% of current ICT workers. While university student numbers in ICT are gradually increasing (as discussed in Section 1.6), there can be a long turnaround from improving the supply of ICT graduates to developing workers with the skills and experience needed by Australian businesses with increasing digital requirements.

Relying on workers from overseas can assist in addressing acute shortages of particular ICT skills in the short term. However, this is not a suitable solution for sustaining Australia's increasing demand for digital skills in the long-term future. Drawing on the existing labour resources within the economy – including the current workforce, as well as individuals who are presently unemployed or underemployed – can be a better way of ensuring that the domestic labour force is sufficiently supplied with ICT skills.

This means that developing the digital skills of both existing ICT workers and the broader Australian population will be an important factor in ensuring that there is an adequate supply of skills given the growing importance of the digital economy and the significant impacts of digital disruption. One way of facilitating this is encouraging existing workers to pursue further education and training opportunities in ICT-related areas, in order to continue building digital skills throughout their career.

3.1.2 The business case for workforce development

Businesses have an important role in ensuring that their employees have the appropriate opportunities to develop their skills through training and learning opportunities at work. When it comes to sourcing skills and talent for their workforce, businesses have to make a difficult choice – do they train their existing staff and develop the required skills internally, or do they hire externally by appointing new staff from other companies or offshore?

There can be advantages associated with hiring skills from the external job market, such as accessing a more diverse pool of candidates and the potential to bring new insights from working in other positions. However, it is important that businesses also recognise the benefits associated with internal workforce development and training their current workers in the required skills. Existing workers are more easily able to apply their new training and skills to the business, given that they have more experience at the firm and are already equipped with organisational knowledge. Providing internal employee development and learning opportunities can also help to improve retention (Florentine 2015).

Previous labour market research has found that sourcing talent internally rather than through external hires can have a positive impact on worker performance and business outcomes. Bidwell (2012) found that employees who were able to develop their skills within the business and were then promoted or transferred into a new role within the same company tended to perform better than workers who were hired externally for similar jobs.

This is in part because of the importance of the firm-specific skills that are already possessed by existing employees, but that need to be developed separately by new hires. There are therefore likely to be significant costs for the business resulting from the reduced productivity associated with new hires adjusting to their new employer and role (Oxford Economics 2014). This shows the importance for companies to be cognisant of the state of skills within their business, with respect to the capabilities of their existing workforce and the skills required for them to operate efficiently and grow. Companies should recognise that it is not always practical to 'buy skills' through external hires, due to the costs of doing so and the fact that it can be difficult to quickly integrate new workers into the business.

Providing internal training and learning opportunities in relation to ICT and digital skills is particularly important given the fact that technology is constantly evolving and new developments are arising all the time. As such, regular workforce development is required to ensure that employees are comfortable with using these new technologies to their full potential. This could involve, for example, implementing a customised IT training program for staff or integrating employee training with IT support (Bickerton 2014).

A number of factors need to be considered by businesses engaging in ICT workforce and skills development. To start, the needs of the organisation and its workforce need to be identified in order to determine where there are gaps that need to be addressed, such as through a training needs analysis (Davey 2007). A suitable response should then be determined, based on the business' overall objectives and priorities as well as the learning styles, training preferences and availability of staff to participate in training and learning opportunities. Upon engaging in an ICT workforce and skills development plan, businesses should review the program regularly to ensure that it is having a positive impact and is updated to reflect new uses and types of technology.

3.2 Assessing gaps in the workforce

Using an ICT capabilities assessment framework such as the Skills Frameworkfor the Information Age (SFIA) can be a useful diagnostic tool for evaluating where there are skills gaps within an organisation's workforce. Companies can subsequently use this information to determine the suitable training and learning opportunities that could be provided to employees to ensure that they can develop the necessary ICT skills.

There are a number of methods that may be used by businesses to assess their ICT skills requirements. An internationally recognised framework that is widely used by businesses across a number of industries is the Skills Framework for the Information Age (SFIA). SFIA is a comprehensive ICT capabilities framework that includes 97 separately identifiable skills, which are each described at one or more of seven levels of responsibility.

For any given organisation, a SFIA assessment can be conducted on skills supply and demand at the individual job role level. On the supply side, each employee is assessed with a skills profile that outlines their individual skillset. On the demand side, job role skills profiles are created for each position based on the business' expectations and validated skill requirements. These profiles can then be reviewed against SFIA assessment to identify skills gaps in the workforce.

As part of this report, we examined SFIA assessments conducted by the ACS on three different organisations under the SFIA 6 framework.[6] The comprehensive nature of SFIA allows each organisation to collect detailed information on skills gaps in their workforce, and gather insights on where training and development opportunities could be required. The following discussion presents some common observations on skills gaps across the three organisations. It should be noted that this is only an indicative analysis that is intended to provide some insights into how an individual company could assess the ICT skills of their workforce, and what they may find in the process.

The data provided suggests that the compliance rate of employee skillsets relative to job role skills profiles is relatively low. On average across all three organisations, only 25% of skills profiled as being necessary across the job roles were sufficiently satisfied by the skillsets of workers employed in the respective role. This suggests that skills shortages were prevalent across the ICT workforces analysed as part of these three SFIA assessments.[7]

In addition, the compliance rate of employee skillsets relative to job role skills profiles for individuals in management-related roles (such as 'lead', 'director', 'manager' or 'head') was on average double that of the overall organisation. This suggests that the skills of ICT workers at relatively senior levels of the business are more likely to be adequate in satisfying organisational requirements. In contrast, ICT skills gaps are more likely to be apparent at the technical and operational level amongst workers such as programmers, engineers, analysts and architects. This could, however, be related to the nature of skills assessments, whereby it may be easier to assess that a worker does not possess a particular level of technical capability, as compared to the 'softer' skills required for management.

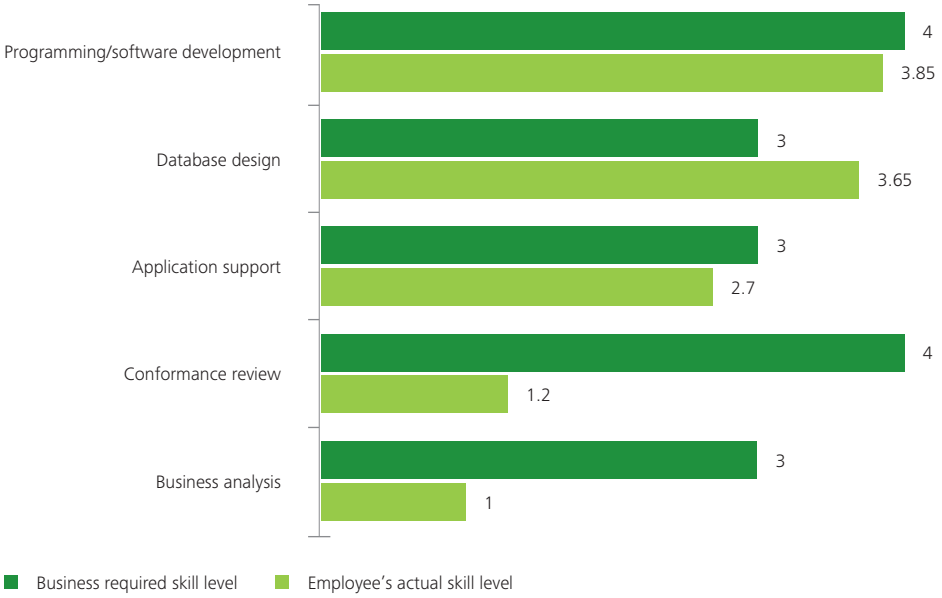
6. Organisation-specific information has been anonymised for the purpose of this report. A total of 166 ICT employees and job roles were profiled for the first organisation, 64 for the second organisation and 91 for the third organisation.

7. It should be noted that on top of this 25% there were also a number of skills profiled for job roles that were almost satisfied by the respective employee skillsets, but were off by a very small amount – that is, the skills and capabilities of the workers in these job roles were very close to, but did not completely fulfil, business requirements. Notwithstanding this, there were still many skills where employees were assessed to be significantly below the standards required by the business across a number of roles.

The SFIA data can also be used to assess the types of skills gaps observed across the three organisations at these levels. For instance, across a number of job roles, employee profiles suggested that they were suitably equipped in the core skills required of their position but not in some of the broader skills that the business had determined were also necessary for the role.

One example of this was in software developer and programmer roles across the three organisations. Employees in these roles typically possessed adequate core technical skills in areas such as such as programming, software development, database design, systems design and application support. However, skills gaps were observed in other required areas such as release and deployment, conformance review, requirements definition and business analysis. Chart 3.1 shows a SFIA assessment of the Senior Analyst Programmer role provided for one of the three organisations, illustrating this general example.

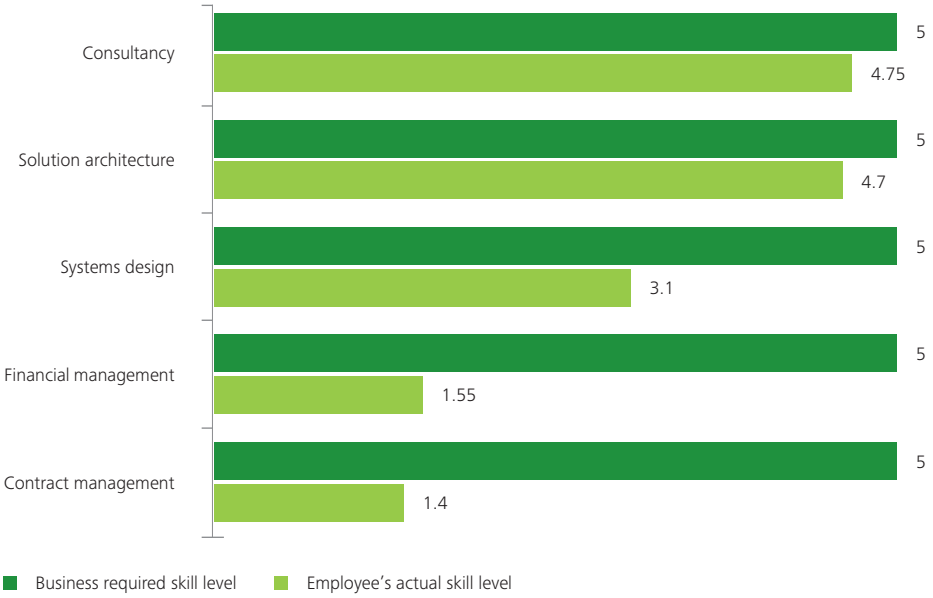
Chart 3.1: Example SFIA assessment – Senior Analyst Programmer



Source: ACS (2016)

A similar observation was made of IT architects across the three organisations. Employees in these roles were generally profiled to be adequately skilled in core areas such as solution, enterprise and business architecture, but skills gaps were reported in broader areas such as management and customer service support. Chart 3.2 shows a SFIA assessment of the ICT Architect role provided for one of the three organisations, illustrating this general example. These examples suggest that for the businesses profiled, there are key gaps in the broader skills of some parts of their ICT workforces that the companies should look to address.

Chart 3.2: Example SFIA assessment – ICT Architect



Source: ACS (2016)

SFIA is a diagnostic tool that companies can use to assess where the ICT skills gaps are within their workforce. Once these gaps have been determined, the company can use this information to determine the suitable training and learning opportunities that could be provided to employees to ensure that the workforce can develop the necessary ICT skills. These could include options such as initiating corporate training programs or providing support for employees to undertake professional certifications or education courses in relevant areas. Other possible professional development opportunities are discussed in more detail in the following section.

3.3 ICT professional development opportunities

A range of options are available to workers looking to upskill or reskill in ICT-related areas, including both formal and informal adult education as well as practical training such as moving across business units and secondments. Companies need to engage with the ICT professional development of their workforce, and use training and learning options as a means for equipping workers with the ICT skills required by the business.

There are a wide variety of training options available to employees for developing their ICT and digital skills. This includes formal education such as by studying a relevant degree or diploma; informal education such as through the completion of short courses or Massive Open Online Courses (MOOCs) or customised corporate ICT training provided by external education providers; and more practical 'learning-by-doing' options such as secondments, on-the-job learning and internal staff rotations. Box 3.2 below includes a schematic that provides more examples of opportunities for employees to develop ICT skills.

Box 3.2: ICT skills development opportunities for the existing workforce

In a world where technological developments are constantly evolving and digital disruption is impacting upon most industries across the Australian economy, it is important for workers to ensure that they possess relevant and up-to-date digital skills. There are a variety of options available to workers looking to upskill or reskill in ICT-related areas, including adult education and practical training opportunities.

University education	Vocational education
• Undergraduate and postgraduate degrees in ICT-related fields • Short courses in computing and ICT • MOOCs on developing ICT skills and competencies.	• Diplomas and certificates in ICT-related fields • Short courses in computing and ICT • ICT traineeships and practical training opportunities.
In-company opportunities	**Other**
• Corporate ICT training programs by external education providers • On-the-job learning and mentoring on ICT skills • Moving staff internally to develop ICT skills across business units.	• Professional qualifications and certifications • Secondments to other organisations to learn new ICT skills and uses • Personal learning and use of ICT outside of work.

Source: Deloitte Access Economics (2016)

In particular, it should be noted that there are many potential opportunities for people looking to enter the ICT workforce to develop relevant skills. As previously discussed, many of the top ICT-related skills demanded by Australian companies can be acquired without necessarily relying on a tertiary qualification. Other options such as informal education, vocational training and professional certifications therefore represent important alternative pathways to formal study at university.

Indeed, a number of companies are recognising the importance of qualifications, experience and training outside of the tertiary education sphere in their recruitment practices. There is an increasing trend away from relying on university results and credentials as the key criteria for hiring decisions, with businesses instead moving towards the use of pre-employment skill tests to assess their talent pool. This is because organisations are recognising that, particularly in rapidly changing areas such as ICT skills, 'the labour market is changing much faster than colleges can keep up' (Lam 2015). As such, companies such as Google are using other methods such as work sample tests and general assessments of cognitive ability in their recruitment processes (Bock 2015).

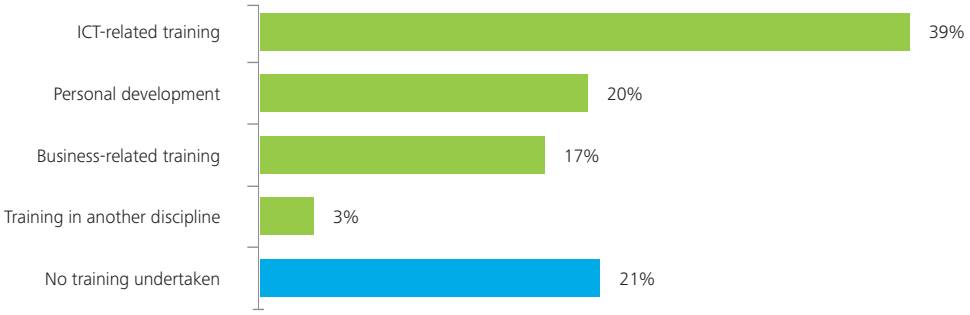
In relation to the ICT training requirements of the existing Australian workforce, the IBSA *ICT Industry Environment Scan* (2015) identified a number of workforce development needs relating to ICT workers and employers, given the challenges associated with the fact that many non-ICT professionals are now required to use ICT skills in their roles. The report found that it is important for industry and training providers engage with each other in order to design and deliver qualifications that are of value and meet the requirements of both Australian businesses and ICT workers.

The report noted that technology-related training options can sometimes fall into silos, which can be unattractive for younger workers looking to develop a broader skillset across various areas of ICT. The provision of training that integrates different aspects of digital technology and ICT could create new entry pathways for workers that might not otherwise have engaged in these learning and development opportunities.

Consultations conducted for this report suggest that some organisations are already aware of the need to provide learning and training opportunities to ensure that their workers are able to develop the ICT skills required by the business. These organisations are offering their employees a variety of options for professional development, including financial support for workers studying ICT-related courses, the provision of in-company training opportunities, and giving workers the opportunity to move around the business to develop new skills.

Evidence suggests that much of the existing ICT workforce is engaging in learning and development opportunities. The 2015 *ACS Employment Survey* found that around 80% of respondents had undertaken training over the previous year. However, only half of these were doing ICT-related training (Chart 3.3). In addition, 47% of all VET enrolments in IT courses were aged 25 years or older, suggesting that a sizeable portion of VET IT students could be people who are already in the workforce seeking to upskill or reskill in technology-related areas. These include current employees who are working towards a career change as well as individuals who are seeking to re-enter the workforce after a career break (discussed in further detail in Box 3.3 below).

Chart 3.3: Training undertaken in last 12 months by survey respondents*



* Survey respondents were ACS members and ICT-based members of Professionals Australia

Source: ACS Employment Survey, Professionals Australia (2015)

Box 3.3: ICT vocational education and the workforce

Vocational education and training (VET) can provide important learning opportunities for the development of ICT-related skills. In 2014, there were over 37,000 students enrolled in VET courses in the IT field of education across Australia.

Robin Shreeve, Institute Director of TAFE Western Sydney, sees a mix of students choosing to study ICT courses at the vocational education level. He states that "while the student demographic includes young people looking to start an IT career, it also includes older individuals who are working towards a career change and those who are seeking to return to work after taking a career break". There are also students that possess tertiary degrees from other institutions and areas of study, who have enrolled in a short VET course as a means to gain the necessary skills to enter the ICT workforce.

Many of the skills developed through ICT VET courses relate to user support functions such as configuring and setting up networks as well as the more complex security management of these networks, and the building, installing and maintenance of systems. In addition, there is also the opportunity to attain vendor certification such as ICT Certification for CISCO, VMware and Microsoft. These skills are important in assisting with the application of ICT in businesses and industries across the economy.

The VET sector emphasises the importance of 'soft skills' – such as teamwork, communication and leadership – in addition to technical ICT skills. This is promoted through strong links and engagement with industry more generally, with students able to participate in on-the-job training or part-time study so as to provide the flexibility to develop relevant skills in the workplace. More recently, TAFE Western Sydney has developed a 'pop-up college' model that enables the institute to take training into businesses and worksites in order to upskill employees. This allows for the provision of just-in-time skills development programs in order to address skills gaps and adapt to changing business requirements.

An individual example of collaboration between TAFE and business is the experience of Iain Lackey, who completed a Traineeship in 2014 and 2015 as a Technical Officer with Catholic Education Office Parramatta, supporting IT in Parramatta Diocese schools. During this time, Iain completed a Certificate III in Information Digital Media and Technology and a Certificate IV in Information Technology Networking, through a combination of on-the-job training and assessment, as well as attendance at vacation workshops at Blacktown TAFE. This delivery environment supported Iain in developing technical, interpersonal and customer support skills. Since completing his Traineeship, Iain has gained a full-time position with Catholic Education Office Parramatta and is contributing to the successful implementation of IT infrastructure within the organisation.

Survey results suggest that workers are heavily involved in determining their training needs, with individual employees being at least partly responsible for determining their training requirements around 94% of the time. However, employers were only involved in determining employee training needs in 59% of all cases. While it is important that employees are able to identify where they would like to partake in learning and development and be provided the opportunity to pursue this, it is also critical for employers to be engaging in ICT workforce development as a means for equipping workers with the skills required by the business and addressing skills gaps.

This is particularly the case when employers are making a financial investment in the training of their workers – the survey found that around three-quarters of employers contributed to the costs of employee training and development. In order to ensure a maximum return on this investment, it is important to align expenditure on workforce training and development with the overall skills needs of the business. This will ensure that companies are well placed to transition their businesses to efficiently make use of new technologies and respond to the changes generated by digital disruption.

This requires consideration of where there might be gaps between the ICT skills required by the business and those possessed by existing employees, and then providing suitable training opportunities to address these gaps. Box 3.4 below features a case study on the medical devices manufacturer Cook Medical, with insights on the company's ICT skills requirements and the training and development opportunities offered to ICT workers.

Box 3.4: Cook Medical

Cook Medical is a global manufacturer of medical devices across a range of different medical specialties. The company's Australian division manufactures and distributes medical products across Australia and around the world, which involves a number of complex technological requirements.

A large component of Cook Medical's digital needs relate to supply chain, warehousing, logistics and operations management. The medical device sector is a highly regulated area in the broader health industry. As such, the company has to closely manage and track the stents, grafts and other devices it produces across the entire supply chain – from sourcing the materials and the manufacturing stage, through to warehousing stock and the eventual sale to the customer. This requires a comprehensive database management system to process and store relevant information.

Given the particular ICT requirements associated with Cook Medical's operations, the business employs an internal team of developers to write software specifically tailored to the company's needs and requirements. This requires ICT workers with strong technical skills such as coding and working with Java, SQL, Microsoft, databases, systems architecture and networking, as well as general analytical and problem solving skills. ICT workers with multiple technical skillsets are highly valued at the company, though it can be difficult to source employees with exposure to and experience across a variety of technical areas.

Cook Medical has a strong focus on workforce learning and development in relation to ICT skills. The company provides a number of development opportunities to its employees, including online short courses and intensive training programs in technical skills. Both the employer and employees are involved in determining training needs – the company examines its requirements and where there are skills gaps, and workers can suggest where training could be useful based on their experiences on the job. For example, the business is in the process of migrating to a new domain, which requires specific technical knowledge such as active directory skills. As part of this, workers underwent a training course on the relevant technical skills, which has then been reinforced through applying the new skills to on-the-job learning.

3.4 Overseas examples of ICT workforce development initiatives

Australia can draw on the experiences of other countries to increase or improve on existing ICT training and education options. For example, in Europe there has been significant joint activity and collaboration between government, business and education providers to develop the digital skills of workers and students, while in the United States there are a number of more informal options available for ICT training, such as hackathons and coding bootcamps.

Workforce development in ICT-related skills is a global issue that is impacting upon many countries outside of Australia. Across most developed countries, there is a general recognition of the importance of ICT in increasing productivity and innovation across the economy. For example, the World Economic Forum's *Future of Jobs* report (2016) found that 73% of survey respondents from the ICT industry believe that future workforce planning is a key leadership priority in order for businesses to adapt to the trends and disruptions that are expected to impact upon the industry over the coming years.

As such, governments and businesses overseas have implemented a number of initiatives with the goal of improving ICT skills, both for ICT workers and the broader workforce. For example, in Europe the European Commission works closely with private sector ICT companies and education providers to increase the availability of ICT-related training programs, while in the US the government has recognised the value of more informal ICT learning and development opportunities such as 'hackathons' and 'bootcamps'.

Australian businesses, governments and education providers could potentially draw on the experiences of these other countries to increase or improve on the training and education options currently available to the existing workforce to develop their ICT skills.

3.4.1 European Union

The European Commission (EC) launched the Grand Coalition for Digital Jobs in 2013, which aims to facilitate collaboration between businesses and education providers to attract young people into ICT education and retrain unemployed people with digital skills. The Coalition recognises that digital technology complements existing tasks across 90% of jobs – including engineering, accounting, nursing and architecture – and as such most citizens will be required to possess some level of digital skills to work, learn and participate in society (EC 2015).

As part of the Coalition, more than 80 stakeholders (including small and large companies, education providers and non-government organisations) have pledged concrete commitments to act to reduce digital skills gaps. For example, as part of its pledge to the Coalition, Google has invested in a number of initiatives to provide ICT skills training to 1 million Europeans by 2016. Training programs have been introduced across a number of countries including Germany, Spain, Italy, France and the United Kingdom (UK), with many working to assist small businesses in using digital tools to sell, market and export their products. The company will also build a Europe-wide training hub to support businesses across Europe to get training online.

Another member of the Coalition is the British Broadcasting Corporation (BBC), which hosts an online academy that provides extensive training and development material including for ICT-related skills. The academy targets students, industry professionals and workers in the broader workforce who are seeking to improve their digital skills. Topics covered include software engineering, data analytics, online development and broadcast technology and social media, with contributions from a large range of companies and global technology experts. As part of its pledge to the Coalition, the BBC agreed to remove geo-blocking of its academy pages to increase accessibility – the academy is expected to reach 2.5 million users by 2016.

In addition, the EC sponsors an annual EU Code Week, which aims to improve the visibility of coding and provide tools to develop coding skills. In 2014, more than 1,500 events were held across Europe as part of Code Week, with the initiative being supported by a number of tech and IT companies including Microsoft, Facebook, SAP and Oracle. Coinciding with this initiative, the EC also sponsors the industry-led European Coding Initiative, which promotes coding and computational thinking at various levels of formal education as well as in more informal training settings, and seeks to teach coding skills to students, teachers and experienced workers.

The UK has also formed the Tech Partnership, a network of employers collaborating to create the ICT skills required to accelerate the growth of the digital economy. The Partnership aims to deliver the skills for a million new digital jobs over the next decade, with four areas of particular focus: apprenticeships, cyber security skills, inspiring young people and women in tech. It hosts a number of online resources for companies and workers, including professional standards for ICT skills across key disciplines of the tech profession (based on SFIA capabilities) and information on ICT training providers with training programs in digital skills.

3.4.2 United States (US)

In the US, President Barack Obama has made digital skills a key focus in school education, recently announcing a new 'Computer Science for All' initiative which aims to improve computer science courses and learning opportunities across primary and secondary schools around the country (White House 2016). On the workforce development front, a review of federal employment and training programs, led by Vice President Joe Biden, reported that increasing the number of people with ICT skills in order to meet demand for jobs in areas such as cyber security, network administration, web design, coding and data analytics should be a key focus across the country (White House 2014).

In particular, the review highlighted that for many employers, demand for ICT talent does not solely equate to university degrees and advanced qualifications – many businesses require ICT skills that can be taught in less than a year in more informal settings. One of the most engaging informal methods of sharing and developing ICT skills are 'hackathons': events where computer programmers and others involved in software and hardware development, such as project managers and interface designers, gather to collaborate on software projects. Hackathons tend to have a specific focus – such as the programming language used, the operating system or application, or the subject and target demographic group – but can in some cases have no restriction on the type of software being created.

Hackathons are hosted by all manner of organisations, including universities, companies, governments and interest groups. While the events originated in the US, hackathons are now run by organisations around the world. Many businesses choose to run hackathons internally as way of generating innovation and providing employees with an opportunity to collaborate through a practical application of ICT skills and knowledge sharing amongst peers. Large tech companies such as Netflix, Facebook, Google, Microsoft and Hewlett Packard have all held internal hackathons to promote new product innovation and, for example, Facebook's 'Like' button and the ability to 'tag' friends in comments were both conceived during an internal hackathon (Keyani 2012).

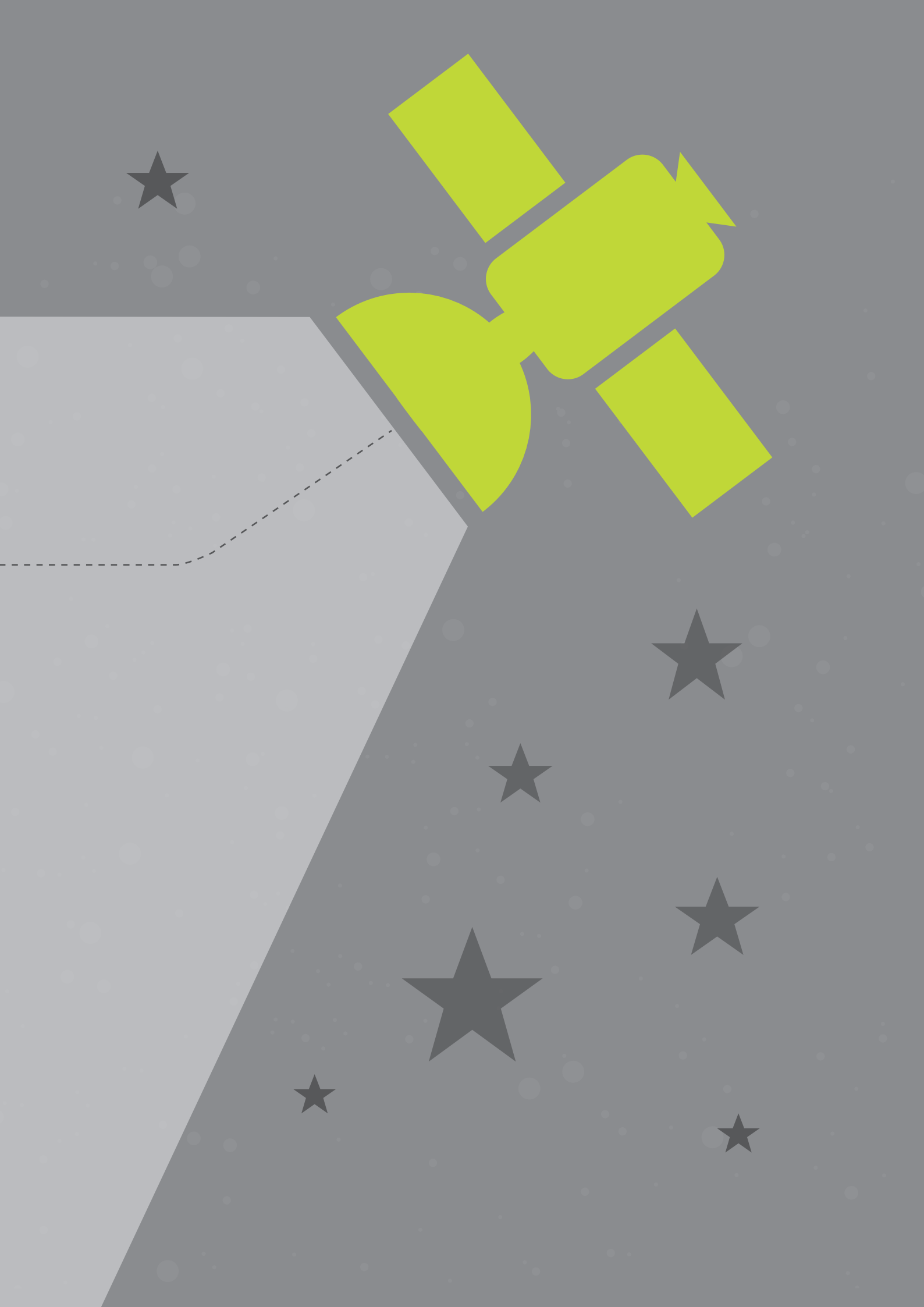
A number of US government agencies also support hackathons. The General Services Administration has hosted annual hackathons since 2014. The events aim to develop ICT solutions to specific issues, such as improving the Federal Government's travel booking process (GSA 2015). NASA likewise hosts an annual hackathon aimed to develop tools to improve space exploration (NASA 2015), while the US Department of State hosts the 'Fishackathon', an annual hackathon on establishing new methods of collecting and analysing data for the fishing industry.

Another rapidly growing group of programs relating to ICT skills development in the US is coding 'bootcamps'. These bootcamps offer intensive courses in coding and programing skills over a short period of time, typically 9 to 12 weeks. They are generally aimed at individuals with minimal prior coding knowledge and can provide a relatively rapid response to skills gaps in the workforce by targeting in-demand skills. For example, a number of bootcamps in 2015 focused on the Ruby programming language, in part due to the strong demand for Ruby coding skills amongst startups (McAlone 2015).

An evaluation of coding bootcamps in the US conducted by Course Report (2015) found that the average bootcamp attendee is 31 years old, has almost 8 years of work experience, has at least an undergraduate degree and has never worked as a programmer. Interestingly, 36% of bootcamp attendees were women – more than twice the share of females studying undergraduate computer science in the US. The report found evidence that participating in a coding bootcamp leads to an increase in employee salaries, with the average worker earning 38% more following the bootcamp. Almost 1 in 10 bootcamp students had enrolled in order to develop the skills to start their own business or become a technical cofounder – which could have broader benefits for economy-wide employment, given that start-ups tend to be significant job creators in the US (Harrison 2013).

However, coding bootcamps in the US can be quite costly to attend, with charges of around US$10,000 to US$15,000 for a 3 month program. The US Government has recently recognised the positive impact that bootcamps can have for ICT skills development through the launch of the Educational Quality through Innovation Partnership (EQUIP) pilot program, which allows federal student loans to be accessible to people attending approved coding bootcamps. This will provide a new source of funding for bootcamp education, and could lead to greater take up of coding bootcamp programs by existing workers seeking to develop their technical ICT skills.

4 Future directions



Demand for ICT skills and workers is increasing as the disruptive impact of digital technologies spreads across the Australian economy. To position our economy to take full advantage of the opportunities presented by this digital disruption, we must ensure that the Australian workforce is equipped with the ICT skills required for businesses to innovate and grow. While ICT education such as introducing coding in schools will facilitate this in the long run, our greatest source of skills right now is the existing workforce. As such, developing the digital skills of both existing ICT workers and the broader Australian workforce is an important factor in ensuring that there is an adequate supply of ICT skills in a growing digital economy.

Australian businesses need to be the driving force for this, both now and in the future. Responding to digital disruption and technological change can require changes to a business' products, operations, processes and infrastructure. Associated with these, there can also be significant changes to the digital skills required of both ICT workers and the broader workforce. Companies need to be aware of this, and should therefore work to identify their ICT skills requirements and consider whether there are any skills gaps amongst their existing workforce: capability assessments and competency-based frameworks such as SFIA can be useful diagnostic tools for this purpose.

Providing appropriate training and learning opportunities for workers to develop the required ICT skills is another important step. This report has outlined a number of options available for experienced workers to develop new or deeper ICT knowledge, including formal tertiary qualifications, professional certifications, short online courses and corporate training programs. An effective digital transition requires business engagement with their workforce in determining skills requirements and what training might be required to meet any skills gaps. Companies should invest in ICT-related learning and development, but this investment should be undertaken with a particular view to upskilling or reskilling workers with the digital skills necessary for furthering growth in the digital age.

There may be a role for Government to highlight the importance of ICT workforce development initiatives by prioritising programs that support ICT-related skills development. While the National Innovation and Science Agenda has been a good start to the ICT skills discussion, the planned initiatives focus on students and are relatively light on the topic of existing workforce development. Existing government-funded training and education programs could be prioritised to support ICT-related training and learning opportunities that are shown to be beneficial in terms of filling skills gaps or facilitating digital growth and innovation within Australian businesses. These could also be targeted towards upskilling or reskilling specific groups of workers that are particularly likely to benefit from training opportunities, such as older workers seeking to develop new ICT skills.

Universities and other education providers can also assist by considering how their ICT course offerings could be used to better meet the needs of employers in the digital age. Given the rapidly changing nature of ICT and the digital skills required by businesses, the courses offered to students and workers may need to be adapted to these new developments in order to remain relevant in the workforce – for example, with respect to course content, length and structure. Partnerships between universities and businesses – combining universities' educational resources and businesses' practical expertise – can be an effective way of ensuring that students and workers are able to engage in high quality and relevant ICT learning and development opportunities.

It is important that Australian businesses take advantage of the economic opportunities presented by future digital disruption, and the potential gains to be had through the impact of technological developments on increasing productivity and innovation across the economy. To do so, Australian workers need to be suitably trained in the ICT skills that will be required in the jobs of the future. ICT workforce and skills development is therefore a critical issue for ensuring that Australia's digital economy continues to grow to its full potential over future years.

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5 Appendix: Statistical Compendium

$138.5bn

Forecast economic contribution of the internet and digital technologies in Australia in 2019-20

628,810

ICT workers in Australia

5.4%

ICT workers' proportion of total workforce

28%

Female share of ICT workers

$6.1bn

Businesses' ICT research and development expenditure

11%

Older workers (aged 55+) share of ICT workers

29,389

ICT university enrolments by domestic students

At a glance – Australia

Table A.1: Summary of key national statistics

Indicator	Statistic	Period
Economic contribution of the internet and digital technologies in Australia – actual	$78.8bn	2013-14
Economic contribution of the internet and digital technologies in Australia – forecast	$138.5bn	2019-20
ICT workers in Australia	628,810	2015
of which: ICT-related industry subdivisions	298,236	2015
Other industries	330,574	2015
of which: Technical, professional, management and operational occupations	419,997	2015
Other occupations (including trades and sales)	208,813	2015
ICT workers' proportion of total workforce	5.4%	2015
Forecast size of Australia's ICT workforce	695,364	2020
Inbound temporary migration of ICT workers (457 visas granted)	13,937	2014-15
Net migration inflow of ICT workers	19,642	2014-15
Female share of ICT workers	28%	2015
Older workers (aged 55+) share of ICT workers	11%	2015
Business' ICT research and development expenditure	$6.1bn	2013-14
Total ICT services exports	$2.3bn	2014-15
Total ICT services imports	$2.6bn	2014-15
ICT university enrolments by domestic students	29,389	2014
ICT university completions by domestic students	5,106	2014

Source: ABS cat. 5368.0 (2015), 8104.0 (2015) and customised report (2015), Deloitte Access Economics (2015), Department of Education u-Cube (2016), Department of Immigration and Border Protection Subclass 457 Visa Statistics (2016) and Overseas Arrivals and Departures Statistics (2016)

At a glance – States and Territories

Table A.2: Summary of key state statistics

Indicator	NSW	VIC	QLD	SA	WA	TAS	ACT & NT
ICT workers in Australia (2015)	234,924	183,247	95,402	33,968	47,011	7,906	26,362
of which: ICT-related industry subdivisions	120,589	94,039	47,034	20,186	27,395	4,492	16,848
Other industries	114,335	89,208	48,368	13,782	19,616	3,414	9,514
of which: Technical, professional, management and operational occupations	157,138	125,340	62,031	21,415	30,369	4,301	19,406
Other occupations (including trades and sales)	77,786	57,907	33,371	12,553	16,642	3,605	6,956
ICT workers' proportion of total workforce (2015)	6.4%	6.2%	4.1%	4.2%	3.4%	3.3%	7.7%
ICT university enrolments by domestic students (2014)	9,938	8,405	5,944	1,541	1,799	370	1,300
ICT university completions by domestic students (2014)	1,705	1,531	954	244	383	58	213

Source: ABS customised report (2015), Department of Education u-Cube (2016)

ICT employment

Table A.3: CIIER classification of ICT workers at the 4-digit 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
2631 Computer Network Professionals
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; & 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 ICT workers

Sources: ACS and CIIER

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

1111 Chief Executives and Managing Directors	2247 Management and Organisation Analysts
1112 General Managers	2249 Other Information and Organisation Professionals
1311 Advertising and Sales Managers	2251 Advertising and Marketing Professionals
1320 Business Administration Managers nfd	2252 ICT Sales Professionals
1322 Finance Managers	2320 Architects, Designers, Planners and Surveyors nfd
1323 Human Resource Managers	2321 Architects and Landscape Architects
1324 Policy and Planning Managers	2322 Cartographers and Surveyors
1332 Engineering Managers	2326 Urban and Regional Planners
1335 Production Managers	2331 Chemical and Materials Engineers
1336 Supply and Distribution Managers	2332 Civil Engineering Professionals
1351 ICT Managers	2333 Electrical Engineers
1419 Other Accommodation and Hospitality Managers	2334 Electronics Engineers
1494 Transport Services Managers	2335 Industrial, Mechanical and Production Engineers
2210 Accountants, Auditors and Company Secretaries nfd	2336 Mining Engineers
2211 Accountants	2341 Agricultural and Forestry Scientists
2212 Auditors, Company Secretaries and Corporate Treasurers	2342 Chemists, and Food and Wine Scientists
2220 Financial Brokers and Dealers, and Investment Advisers nfd	2343 Environmental Scientists
2221 Financial Brokers	2344 Geologists and Geophysicists
2222 Financial Dealers	2345 Life Scientists
2223 Financial Investment Advisers and Managers	2346 Medical Laboratory Scientists
2232 ICT Trainers	2349 Other Natural and Physical Science Professionals
2241 Actuaries, Mathematicians and Statisticians	2512 Medical Imaging Professionals
2242 Archivists, Curators and Records Managers	2600 ICT Professionals nfd
2243 Economists	2610 Business and Systems Analysts, and Programmers nfd
2244 Intelligence and Policy Analysts	2611 ICT Business and Systems Analysts
2246 Librarians	2612 Multimedia Specialists and Web Developers

2613 Software and Applications Programmers	5100 Office Managers and Program Administrators nfd
2621 Database and Systems Administrators, and ICT Security Specialists	5121 Office Managers
2630 ICT Network and Support Professionals nfd	5122 Practice Managers
2631 Computer Network Professionals	5211 Personal Assistants
2632 ICT Support and Test Engineers	5212 Secretaries
2633 Telecommunications Engineering Professionals	5321 Keyboard Operators
2710 Legal Professionals nfd	5510 Accounting Clerks and Bookkeepers nfd
2711 Barristers	5511 Accounting Clerks
2712 Judicial and Other Legal Professionals	5512 Bookkeepers
2713 Solicitors	5513 Payroll Clerks
3100 Engineering, ICT and Science Technicians nfd	5521 Bank Workers
3123 Electrical Engineering Draftspersons and Technicians	5522 Credit and Loans Officers
3124 Electronic Engineering Draftspersons and Technicians	5523 Insurance, Money Market and Statistical Clerks
3130 ICT and Telecommunications Technicians nfd	6111 Auctioneers, and Stock and Station Agents
3131 ICT Support Technicians	6112 Insurance Agents
3132 Telecommunications Technical Specialists	6212 ICT Sales Assistants
3400 Electrotechnology and Telecommunications Trades Workers nfd	6399 Other Sales Support Workers
3420 Electronics and Telecommunications Trades Workers nfd	7123 Engineering Production Systems Workers
3423 Electronics Trades Workers	

Source: OECD (2012)

Table A.5: ICT workers by industry and CIIER occupation grouping, 2015

	ICT management and operations	ICT technical and professional	ICT sales	ICT trades	Electronic trades and professional	ICT industry admin and logistics support	Total ICT workers
Industry divisions							
Agriculture, Forestry and Fishing	266	0	0	0	0	0	266
Mining	1,690	2,355	0	236	0	0	4,281
Manufacturing	9,105	12,376	510	3,029	0	0	25,020
Electricity, Gas, Water and Waste Services	3,884	3,395	75	1,580	0	0	8,934
Construction	2,638	2,210	0	5,760	0	0	10,608
Wholesale Trade	6,684	4,713	3,433	2,239	0	0	17,069
Retail Trade	5,995	7,128	7,037	2,866	0	0	23,026
Accommodation and Food Services	935	1204	345	409	0	0	2,893
Transport, Postal and Warehousing	7,353	3,911	0	2375	0	0	13,639
Rest of Information, Media and Telecommunications*	2,285	5,788	0	1,770	0	0	9,843
Financial and Insurance Services	21,302	15,563	21	3,391	0	0	40,277
Rental, Hiring and Real Estate Services	1,229	1,325	117	384	0	0	3,055
Rest of Professional, Scientific and Technical Services**	29,323	34,706	310	2,298	0	0	66,637
Administrative and Support Services	5,700	3,103	340	1,433	0	0	10,576
Public Administration and Safety	23,493	14,092	642	5,533	0	0	43,760
Education and Training	11,772	5,699	143	4,747	0	0	22,361
Health Care and Social Assistance	8,840	4,960	261	2,513	0	0	16,574
Arts and Recreation Services	1,262	4,734	0	0	0	0	5,996
Other Services	1,628	2,237	0	1,894	0	0	5,759

	ICT management and operations	ICT technical and professional	ICT sales	ICT trades	Electronic trades and professional	ICT industry admin and logistics support	Total ICT workers
ICT industry subdivisions							
Telecommunications Services	12,260	15,964	7,349	14,648	852	40,496	91,569
Internet Service Providers, Web Search Portals and Data Processing Services	2,290	1,477	892	499	0	4,968	10,126
Computer System Design and Related Services	34,670	78,453	11,119	16,268	2,787	53,244	196,541
Total ICT workers	**194,604**	**225,393**	**32,594**	**73,872**	**3,639**	**98,708**	**628,810**

* Excluding Telecommunications Services & 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 (2015)

Table A.6: ICT employment forecasts by CIIER occupation grouping, 2015 to 2020

	2015	2020	Average annual growth
ICT management and operations	194,604	217,992	2.3%
ICT technical and professional	225,393	251,592	2.2%
ICT sales	32,594	36,211	2.1%
ICT trades	73,872	80,050	1.6%
Electronic trades and professional*	3,639	3,712	0.4%
ICT industry admin and logistics support*	98,708	105,808	1.4%
Total ICT workers	**628,810**	**695,364**	**2.0%**

*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 (2016)

Table A.7: ICT skills forecasts by CIIER occupation grouping, 2015 to 2020

	2015	2020	Average annual growth
ICT management and operations			
Postgraduate	81,562	94,440	3.2%
Undergraduate	146,521	167,172	3.0%
Adv dip/Dip	58,502	64,816	2.6%
Cert III/IV	37,176	44,453	3.6%
Cert I/II	18,250	20,913	3.1%
ICT technical and professional			
Postgraduate	76,970	85,489	2.4%
Undergraduate	188,396	210,658	2.5%
Adv dip/Dip	72,889	79,523	2.0%
Cert III/IV	40,368	47,528	3.0%
Cert I/II	20,597	23,483	2.5%
ICT sales			
Postgraduate	6,213	7,838	3.4%
Undergraduate	13,058	15,744	2.9%
Adv dip/Dip	5,918	6,664	2.1%
Cert III/IV	5,104	6,168	2.9%
Cert I/II	2,813	3,245	2.3%
ICT trades			
Postgraduate	18,468	21,596	2.5%
Undergraduate	33,473	39,727	2.7%
Adv dip/Dip	22,617	25,725	2.2%
Cert III/IV	26,800	29,269	1.9%
Cert I/II	15,352	17,516	2.3%

Source: Deloitte Access Economics (2016)

	2015	2020	Average annual growth
Electronic trades and professional			
Postgraduate	341	348	0.6%
Undergraduate	818	858	0.9%
Adv dip/Dip	1,253	1,271	0.6%
Cert III/IV	2,116	2,227	1.0%
Cert I/II	882	941	1.0%
ICT industry admin and logistics support			
Postgraduate	26,255	38,075	3.7%
Undergraduate	35,982	50,100	3.2%
Adv dip/Dip	15,362	20,852	2.9%
Cert III/IV	15,800	22,531	3.6%
Cert I/II	5,722	7,866	3.1%

Source: Deloitte Access Economics (2016)

ICT migration

Table A.8: Temporary skilled migration (457) visa grants for ICT occupations, 2011-12 to 2014-15

	2011-12	2012-13	2013-14	2014-15
1351 ICT Managers	804	902	786	939
2232 ICT Trainers	23	26	15	10
2247 Management and Organisation Analysts	1,767	1,396	1,239	1,445
2249 Other Information and Organisation Professionals	689	478	445	452
2252 ICT Sales Professionals	415	525	458	527
2324 Graphic and Web Designers, and Illustrators	407	477	307	472
2611 ICT Business and Systems Analysts	2,013	2,111	1,795	2,098
2612 Multimedia Specialists and Web Developers	94	141	117	162
2613 Software and Applications Programmers	5,388	4,602	4,161	5,231
2621 Database and Systems Administrators, and ICT Security Specialists	532	560	356	383
2631 Computer Network Professionals	336	276	240	272
2632 ICT Support and Test Engineers	668	717	671	767
2633 Telecommunications Engineering Professionals	240	197	53	127
3123 Electrical Engineering Draftspersons and Technicians	535	524	365	351
3124 Electronic Engineering Draftspersons and Technicians	233	197	147	112
3131 ICT Support Technicians	358	448	340	320
3132 Telecommunications Technical Specialists	315	118	61	52
3423 Electronics Trades Workers	222	154	88	115
3424 Telecommunications Trades Workers	117	103	161	102
Total ICT workers*	**15,156**	**13,952**	**11,805**	**13,937**

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

Source: Department of Immigration and Border Protection Subclass 457 Visa Statistics (2016)

Table A.9: Net migration of ICT workers, 2012-13 to 2014-15

	2012-13	2013-14	2014-15
1351 ICT Managers	1,561	1,212	1,350
2232 ICT Trainers	37	45	89
2247 Management and Organisation Analysts	3,127	2,409	1,991
2249 Other Information and Organisation Professionals	1,281	1,223	1,150
2252 ICT Sales Professionals	1,112	1,260	1,347
2324 Graphic and Web Designers, and Illustrators	728	631	823
2611 ICT Business and Systems Analysts	2,609	2,503	3,018
2612 Multimedia Specialists and Web Developers	120	179	162
2613 Software and Applications Programmers	5,212	5,152	5,324
2621 Database and Systems Administrators, and ICT Security Specialists	672	610	579
2631 Computer Network Professionals	427	342	281
2632 ICT Support and Test Engineers	710	969	984
2633 Telecommunications Engineering Professionals	246	118	188
3123 Electrical Engineering Draftspersons and Technicians	800	733	864
3124 Electronic Engineering Draftspersons and Technicians	464	314	240
3131 ICT Support Technicians	708	670	602
3132 Telecommunications Technical Specialists	248	274	237
3423 Electronics Trades Workers	285	167	192
3424 Telecommunications Trades Workers	173	298	221
Total ICT workers*	**20,520**	**19,109**	**19,642**

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

Source: Department of Immigration and Border Protection Overseas Arrivals and Departures Statistics (2016)

ICT higher and vocational education

Table A.10: Domestic enrolments and completions in IT degrees, 2001 to 2014

	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	31,323	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
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

Source: Department of Education u-Cube (2016)

Table A.11: VET enrolments in the IT field of education, 2010 to 2014

	2010	2011	2012	2013	2014
Adv dip/Dip	7,370	6,642	6,168	6,479	8,757
Cert III/IV	16,853	17,592	18,675	19,605	19,889
Cert I/II	701	915	7,604	9,213	8,133

Source: National Centre for Vocational Education Research (2016)

Table A.12: Female ICT workers by industry, 2015

	Female ICT workers	Female % of ICT workers	Female % of all occupations
Industry divisions			
Agriculture, Forestry and Fishing	0	0%	33%
Mining	850	20%	14%
Manufacturing	5,831	23%	27%
Electricity, Gas, Water and Waste Services	1,694	19%	21%
Construction	1,195	11%	12%
Wholesale Trade	2,801	16%	33%
Retail Trade	5,850	25%	55%
Accommodation and Food Services	389	13%	54%
Transport, Postal and Warehousing	2,460	18%	23%
Rest of Information, Media and Telecommunications*	2,795	28%	43%
Financial and Insurance Services	13,342	33%	50%
Rental, Hiring and Real Estate Services	914	30%	49%
Rest of Professional, Scientific and Technical Services**	22,835	34%	41%
Administrative and Support Services	3,608	34%	49%
Public Administration and Safety	15,928	36%	48%
Education and Training	6,946	31%	70%
Health Care and Social Assistance	6,412	39%	79%
Arts and Recreation Services	1,573	26%	47%
Other Services	1,135	20%	42%
ICT industry subdivisions			
Telecommunications Services	29,360	32%	32%
Internet Service Providers, Web Search Portals and Data Processing Services	2,223	22%	22%
Computer System Design and Related Services	46,285	24%	24%
Total ICT workers	**174,426**	**28%**	**46%**

* Excluding Telecommunications Services & 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 (2015)

Older ICT workers

Table A.13: Older ICT workers by CIIER occupation grouping, 2015

	Number of ICT workers aged 55+ years	Share of total ICT workforce
ICT management and operations	27,130	14%
ICT technical and professional	2,309	7%
ICT sales	18,482	8%
ICT trades	7,417	10%
Electronic trades and professional*	6,327	14%
Total ICT workers*	**61,665**	**11%**

* 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 (2015)

ICT research and development

Table A.14: Business expenditure on research and development, 2009-10 to 2013-14

	2009-10	2010-11	2011-12	2013-14
Engineering	$8,798,300	$9,283,280	$8,686,256	$7,474,231
Information and Computing Sciences	$4,760,255	$5,001,174	$5,496,165	$6,073,221
Technology	$768,909	$917,109	$1,235,487	$1,689,446
Medical and Health Sciences	$920,658	$928,398	$941,159	$1,123,956
Chemical Sciences	$250,242	$275,030	$425,941	$565,758
Agricultural and Veterinary Sciences	$417,759	$492,921	$455,372	$553,754
Earth Sciences	$153,063	$200,390	$122,476	$286,511
Environmental Sciences	$154,503	$192,797	$281,155	$270,044
Built Environment and Design	$201,860	$309,244	$231,743	$238,591
Commerce, Management, Tourism and Services	$99,316	$152,605	$144,273	$227,088
Other fields of research	$234,776	$253,939	$301,295	$346,838

Source: ABS cat 8104.0 (2015)

Trade in ICT services

Table A.15: Exports and imports of ICT services, 2010-11 to 2014-15

	2010-11	2011-12	2012-13	2013-14	2014-15
Exports	$1.56bn	$1.51bn	$1.58bn	$1.71bn	$2.31bn
Imports	$1.65bn	$1.66bn	$1.84bn	$2.5bn	$2.56bn

Source: ABS cat 5368.0 (2015)

Detailed state figures

Table A.16: State breakdown of ICT workers by industry, 2015

	NSW	VIC	QLD	SA	WA	TAS	ACT & NT
Industry divisions							
Agriculture, Forestry and Fishing	0	0	139	0	0	127	0
Mining	165	340	973	183	2,461	78	79
Manufacturing	9,222	9,804	2,778	1,267	1,531	217	202
Electricity, Gas, Water and Waste Services	3,109	2,652	951	889	590	381	363
Construction	3,207	2,738	1,554	868	1,692	195	353
Wholesale Trade	8,151	4,545	2,046	1,056	814	0	457
Retail Trade	8,851	7,388	3,541	1,083	1,626	143	394
Accommodation and Food Services	1,825	0	404	257	345	0	62
Transport, Postal and Warehousing	3,928	4,643	2,508	322	1,606	0	632
Rest of Information, Media and Telecommunications*	4,926	2,044	1,838	531	203	36	263
Financial and Insurance Services	20,052	13,734	3,016	1,141	1,638	336	362
Rental, Hiring and Real Estate Services	906	1,008	310	86	647	0	98
Rest of Professional, Scientific and Technical Services**	24,474	21,038	8,421	3,359	6,573	998	1,780
Administrative and Support Services	4,972	2,490	2,382	397	119	136	83
Public Administration and Safety	11,000	7,321	5,697	4,913	3,770	1,093	9,964
Education and Training	6,622	7,058	3,671	2,455	1,248	348	960
Health Care and Social Assistance	5,919	4,042	3,300	876	1,715	269	457
Arts and Recreation Services	1,295	1,740	2,192	256	410	0	101
Other Services	1,965	1,454	1,313	247	407	135	238

	NSW	VIC	QLD	SA	WA	TAS	ACT & NT
ICT industry subdivisions							
Telecommunications Services	28,674	33,796	14,959	5,917	4,164	1,823	2,236
Internet Service Providers, Web Search Portals and Data Processing Services	5,819	2,118	463	480	652	112	483
Computer System Design and Related Services	79,842	53,294	32,946	7,385	14,800	1,479	6,795
Total ICT workers	234,924	183,247	95,402	33,968	47,011	7,906	26,362

* Excluding Telecommunications Services & 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 (2015)

Table A.17: NSW ICT employment forecasts by CIIER occupation grouping, 2015 to 2020

	2015	2020	Average annual growth
ICT management and operations	74,600	82,176	2.0%
ICT technical and professional	87,330	94,834	1.7%
ICT sales	13,301	14,241	1.4%
ICT trades	24,733	28,415	2.8%
Electronic trades and professional*	1,360	1,371	0.2%
ICT industry admin and logistics support*	33,601	35,710	1.2%
Total ICT workers	**234,924**	**256,746**	**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 (2016)

Table A.18: VIC ICT employment forecasts by CIIER occupation grouping, 2015 to 2020

	2015	2020	Average annual growth
ICT management and operations	61,551	69,772	2.5%
ICT technical and professional	64,449	76,713	3.5%
ICT sales	9,437	10,900	2.9%
ICT trades	19,363	20,640	1.3%
Electronic trades and professional*	1,060	1,117	1.0%
ICT industry admin and logistics support*	27,387	30,074	1.9%
Total ICT workers	**183,247**	**209,216**	**2.7%**

*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 (2016)

Table A.19: QLD ICT employment forecasts by CIIER occupation grouping, 2015 to 2020

	2015	2020	Average annual growth
ICT management and operations	25,955	28,578	1.9%
ICT technical and professional	34,278	35,992	1.0%
ICT sales	4,743	5,959	4.7%
ICT trades	12,810	12,776	-0.1%
Electronic trades and professional*	552	544	-0.3%
ICT industry admin and logistics support*	17,063	18,128	1.2%
Total ICT workers	**95,402**	**101,977**	**1.3%**

*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 (2016)

Table A.20: SA ICT employment forecasts by CIIER occupation grouping, 2015 to 2020

	2015	2020	Average annual growth
ICT management and operations	7,371	9,201	4.5%
ICT technical and professional	13,450	13,678	0.3%
ICT sales	1,564	1,699	1.7%
ICT trades	4,542	5,151	2.5%
Electronic trades and professional*	197	195	-0.2%
ICT industry admin and logistics support*	6,845	6,609	-0.7%
Total ICT workers	**33,968**	**36,532**	**1.5%**

*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 (2016)

Table A.21: WA ICT employment forecasts by CIIER occupation grouping, 2015 to 2020

	2015	2020	Average annual growth
ICT management and operations	12,858	14,798	2.9%
ICT technical and professional	15,232	18,027	3.4%
ICT sales	2,337	2,192	-1.3%
ICT trades	7,503	7,885	1.0%
Electronic trades and professional*	272	282	0.8%
ICT industry admin and logistics support*	8,808	9,725	2.0%
Total ICT workers	**47,011**	**52,908**	**2.4%**

*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 (2016)

Table A.22: TAS ICT employment forecasts by CIIER occupation grouping, 2015 to 2020

	2015	2020	Average annual growth
ICT management and operations	2,416	2,656	1.9%
ICT technical and professional	2,172	2,247	0.7%
ICT sales	423	400	-1.1%
ICT trades	1,523	1,552	0.4%
Electronic trades and professional*	46	46	0.1%
ICT industry admin and logistics support*	1,326	1,721	5.3%
Total ICT workers	**7,906**	**8,622**	**1.7%**

*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 (2016)

Table A.23: NT & ACT ICT employment forecasts by CIIER occupation grouping, 2015 to 2020

	2015	2020	Average annual growth
ICT management and operations	9,927	10,877	1.8%
ICT technical and professional	8,710	10,218	3.2%
ICT sales	873	950	1.7%
ICT trades	3,179	3,456	1.7%
Electronic trades and professional*	153	157	0.5%
ICT industry admin and logistics support*	3,520	3,704	1.0%
Total ICT workers	**26,362**	**29,362**	**2.2%**

*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 (2016)

Table A.24: State breakdown of net overseas migration of ICT workers, 2014-15*

	NSW	VIC	QLD	WA
1351 ICT Managers	777	382	113	64
2232 ICT Trainers	63	10	0	14
2247 Management and Organisation Analysts	1,034	506	134	315
2249 Other Information and Organisation Professionals	517	197	211	199
2252 ICT Sales Professionals	983	244	53	51
2324 Graphic and Web Designers, and Illustrators	395	263	36	65
2611 ICT Business and Systems Analysts	1,416	1,003	326	167
2612 Multimedia Specialists and Web Developers	97	40	18	9
2613 Software and Applications Programmers	3,025	1,633	318	221
2621 Database and Systems Administrators, and ICT Security Specialists	254	171	60	79
2631 Computer Network Professionals	148	25	46	49
2632 ICT Support and Test Engineers	559	287	58	52
2633 Telecommunications Engineering Professionals	102	34	32	23
3123 Electrical Engineering Draftspersons and Technicians	82	87	152	468
3124 Electronic Engineering Draftspersons and Technicians	39	13	68	114
3131 ICT Support Technicians	341	84	40	88
3132 Telecommunications Technical Specialists	58	75	39	17
3423 Electronics Trades Workers	24	33	15	95
3424 Telecommunications Trades Workers	34	27	44	99
Total ICT workers**	**9,948**	**5,114**	**1,763**	**2,189**

* Data represents net overseas migration only and does not include net interstate migration within Australia; other states and territories not shown for confidentiality reasons (less than 5 workers reported)

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

Source: Department of Immigration and Border Protection Overseas Arrivals and Departures Statistics (2016)

Table A.25: State breakdown of enrolments and completions in IT degrees, 2014

	Course enrolments		Course completions	
	Undergraduate	Postgraduate	Undergraduate	Postgraduate
NSW	8,028	1,910	527	1,178
VIC	6,685	1,720	406	1,125
QLD	5,048	896	248	706
SA	1,245	296	71	173
WA	1,301	498	148	235
TAS	325	45	11	47
NT	114	10	-	9
ACT	994	182	57	147
Multistate	89	3	-	18

Source: Department of Education u-Cube (2016)

International comparisons

Table A.26: Mobile broadband subscriptions per 100 habitants, 2014

Rank	Country	Total mobile subscriptions	Rank	Country	Total mobile subscriptions
1	Finland	138.002	18	Netherlands	68.993
2	Japan	124.107	19	Austria	67.109
3	Sweden	115.552	20	Czech Republic	65.143
4	Denmark	115.507	21	France	64.678
5	**Australia**	**114.369**	22	Germany	63.818
6	Estonia	114.154	23	Slovak Republic	59.91
7	Korea	106.483	24	Belgium	57.723
8	United States	103.953	25	Poland	55.292
9	New Zealand	98.775	26	Canada	54.246
10	Norway	87.979	27	Israel	49.881
11	Iceland	87.264	28	Chile	49.819
12	United Kingdom	84.82	29	Slovenia	46.968
13	Luxembourg	84.369	30	Portugal	45.753
14	Switzerland	83.075	31	Mexico	42.506
15	Ireland	82.081	32	Turkey	42.188
-	OECD	81.289	33	Greece	41.481
16	Spain	78.055	34	Hungary	34.278
17	Italy	70.901			

Source: OECD Key ICT Indicators (2016)

Table A.27: Share of enterprises with broadband connectivity by employment size, 2014

Country	10-49 employees	50-249 employees	250+ employees
Finland	100.0%	100.0%	100.0%
Netherlands	99.5%	99.9%	99.9%
Korea	98.9%	99.7%	99.2%
Denmark	98.7%	99.5%	99.3%
Slovenia	97.8%	99.7%	100.0%
Switzerland	97.7%	99.5%	99.7%
Canada	97.7%	99.4%	99.8%
Spain	97.5%	99.1%	99.7%
Luxembourg	96.6%	98.6%	99.0%
Czech Republic	96.2%	98.9%	99.2%
Sweden	96.2%	99.0%	98.7%
Australia	**96.0%**	**99.6%**	**99.7%**
Austria	95.4%	99.2%	99.3%
New Zealand	95.9%	96.2%	95.0%
Estonia	95.2%	98.8%	98.7%
Belgium	95.1%	98.7%	99.5%

Country	10-49 employees	50-249 employees	250+ employees
France	94.9%	98.6%	99.6%
Ireland	94.8%	98.6%	98.7%
Germany	94.5%	97.8%	99.4%
United Kingdom	94.3%	99.9%	99.3%
Latvia	94.3%	97.9%	99.5%
Italy	94.5%	98.1%	99.3%
Portugal	93.9%	99.0%	100.0%
Iceland	93.3%	97.9%	100.0%
Slovak Republic	92.3%	97.6%	98.0%
Norway	91.9%	97.1%	99.2%
Poland	88.9%	97.7%	99.5%
Turkey	88.4%	96.0%	98.7%
Hungary	86.4%	94.7%	98.9%
Greece	85.3%	98.4%	99.1%
Japan		87.9%	81.7%
Mexico	77.1%	94.4%	97.2%

Source: OECD Key ICT Indicators (2016)

Table A.28: Employment of ICT specialists in the workforce, 2014

Country	Total mobile subscriptions	Country	Total mobile subscriptions
Finland	6.0%	Germany	3.5%
Sweden	5.3%	Czech Republic	3.5%
Luxembourg	5.0%	Slovenia	3.4%
Switzerland	4.9%	Austria	3.3%
United Kingdom	4.7%	Hungary	3.3%
Canada	4.7%	Korea	3.0%
Ireland	4.4%	Portugal	3.0%
Netherlands	4.3%	Spain	3.0%
Iceland	4.2%	France	2.8%
Denmark	4.2%	Italy	2.7%
United States	4.1%	Slovak Republic	2.6%
Estonia	4.0%	Poland	2.4%
Belgium	3.8%	Latvia	2.0%
Australia	**3.8%**	Greece	1.7%
Norway	3.7%	Turkey	1.1%

Source: OECD Key ICT Indicators (2016)

Table A.29: Business ICT research and development expenditure as a share of GDP, 2013

Country	ICT manufacturing	Software publishing	Telecom-munications	IT and other information services	ICT services not allocated
Korea	1.639%	0.085%	0.028%	0.021%	
Chinese Taipei	1.655%	0.002%	0.027%	0.061%	0.003%
Israel	0.305%		0.000%	1.177%	
Finland	0.958%	0.028%	0.013%	0.193%	
United States	0.301%	0.184%	0.014%	0.113%	
Japan	0.474%	0.000%	0.059%	0.038%	0.005%
Sweden	0.465%				0.090%
Ireland	0.057%	0.103%	0.007%	0.225%	0.084%
Singapore	0.396%	0.010%	0.001%	0.030%	0.035%
Iceland	0.000%	0.134%			0.286%
Denmark	0.037%	0.041%	0.026%	0.186%	0.024%
Estonia	0.008%		0.074%	0.224%	0.002%
China	0.239%	0.000%	0.014%	0.043%	
Canada	0.103%	0.032%	0.021%	0.072%	0.023%
Germany	0.134%		0.023%	0.092%	
France	0.085%	0.038%	0.035%	0.082%	0.006%
Austria	0.119%	0.007%	0.016%	0.089%	0.006%
Belgium	0.088%	0.005%	0.055%	0.085%	
Switzerland	0.167%				0.054%
Norway	0.022%	0.049%	0.026%	0.119%	0.004%
Slovenia	0.103%	0.011%	0.007%	0.089%	0.003%

Country	ICT manufacturing	Software publishing	Telecom-munications	IT and other information services	ICT services not allocated
Portugal	0.013%	0.007%	0.080%	0.071%	0.031%
Netherlands	0.051%		0.008%	0.100%	0.019%
United Kingdom	0.020%	0.003%	0.042%	0.099%	0.011%
Hungary	0.045%	0.009%	0.002%	0.102%	0.002%
Czech Republic	0.012%	0.006%	0.015%	0.118%	0.003%
Australia	**0.011%**	**0.009%**	**0.032%**	**0.079%**	**0.007%**
Turkey	0.018%	0.002%	0.023%	0.088%	
Italy	0.053%	0.001%	0.050%	0.018%	0.002%
Spain	0.011%	0.003%	0.025%	0.064%	0.007%
New Zealand				0.107%	
Poland	0.006%				0.067%
Slovak Republic	0.005%				0.043%
Romania	0.011%	0.001%	0.003%	0.030%	0.001%
Greece	0.009%	0.000%	0.014%	0.018%	0.001%
Mexico					

Source: OECD Key ICT Indicators (2016)

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