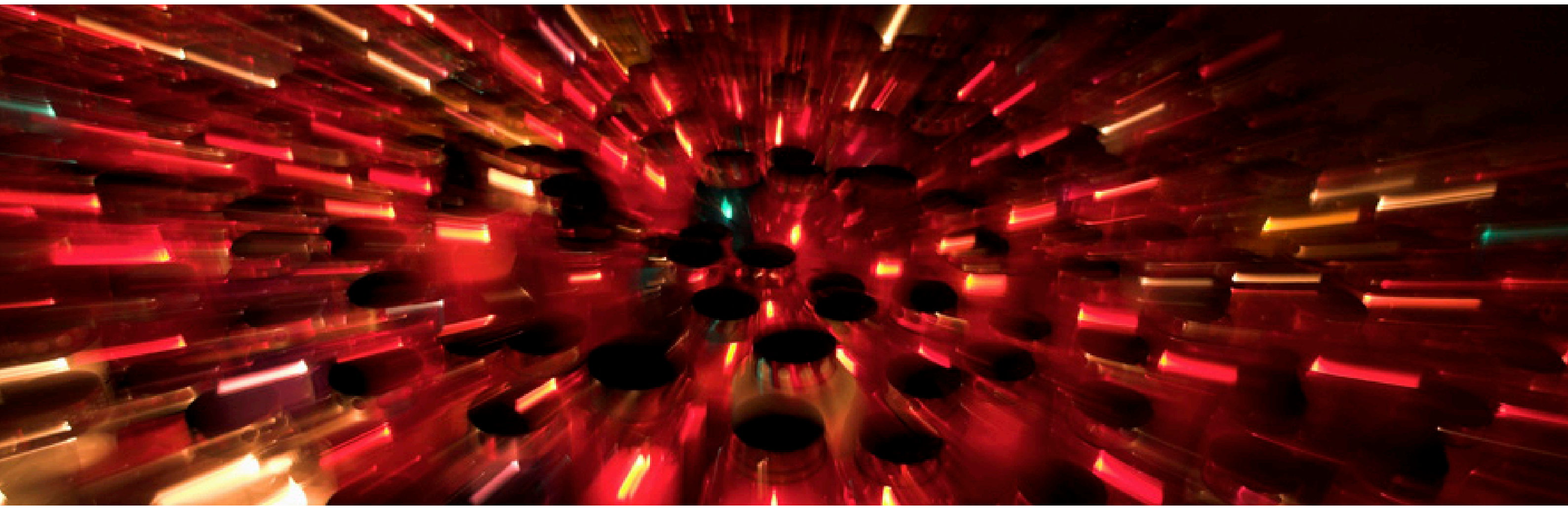
Deloitte Access Economics



Australia's Digital Pulse

Key challenges for our nation – digital skills, jobs and education

Australian Computer Society, 2015

Deloitte.

Contents

Glossary

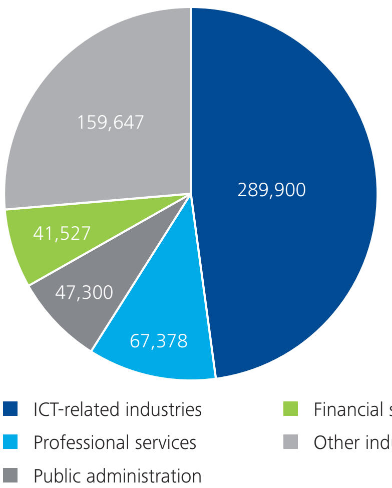
ABS	Australian Bureau of Statistics
ACS	Australian Computer Society
ACARA	Australian Curriculum, Assessment and Reporting Authority
ANZSCO	Australian and New Zealand Standard Classification of Occupations
ANZSIC	Australian and New Zealand Standard Industrial Classification
BOSTES	Board of Studies, Teaching and Educational Standards (NSW)
CIIER	Centre for Innovative Industries Economic Research Inc
DAE	Deloitte Access Economics
DIBP	Department of Immigration and Border Protection
GDP	Gross Domestic Product
HR	Human Resources
ICT	Information and Communications Technology
IMT	Information, Media and Telecommunications (ABS industry)
IT	Information Technology
MOOC	Massive Open Online Course
NAP	National Assessment Program
NICTA	National ICT Australia
NSW	New South Wales
OECD	Organisation for Economic Co-operation and Development
STEM	Science, Technology, Engineering, Mathematics
UTS	University of Technology Sydney
VCAA	Victoria Curriculum and Assessment Authority
VET	Vocational Education and Training

Executive summary

The Australian digital economy has experienced rapid growth over recent years. **The contribution of digital technologies to the Australian economy was $79 billion in 2013–14 compared with $50 billion in 2011**, and is expected to continue growing in a globally-connected digital world.

Digital disruption is dramatically changing industries and occupations across the economy. The number of Information and Communications Technology (ICT) workers[i] increased to 600,000 in 2014, and now more than half (52%) are in industries outside ICT itself including professional services, public administration and financial services (Chart 1).

Chart 1: ICT workers by industries, 2014



Source: ABS customised report (2015)

The changing role of ICT is also evident in education statistics. Almost half (47%) of all workers who studied ICT are in other professions such as advertising, marketing and accounting, while almost half (43%) of workers in ICT occupations studied courses other than ICT or engineering, such as commerce and management degrees. **Industry consultations suggest that Australian businesses across a diverse range of sectors have significant ICT skills needs** (refer to box on next page).

Productivity growth in the Australian economy will be increasingly driven by digital technology in the future, particularly as the mining boom wanes. A strong digital economy is an important economic reform. **Australia needs a workforce that is equipped with the ICT skills necessary to fuel its digitally-driven economic growth**. Professor Roy Green, Dean of the UTS Business School, believes that in the future computational thinking skills and specialised disciplinary thinking need to be combined with business analytics and design thinking in order to foster innovation in the economy.

Australia is already a relatively high user of digital technologies, with impressive penetration rates for mobile broadband and e-commerce. However, there are gaps in Australia's digital capability, having fewer ICT specialists and investing a smaller share of research and development in ICT compared with other OECD countries.

Demand for ICT workers in Australia is forecast to increase by 100,000 workers over six years, from around 600,000 workers in 2014 to more than 700,000 workers in 2020. In particular, growth is expected to be strongest for technical, professional, management and operational occupations (Table 1). This reflects the integration of ICT workers across a broad range of industries as digital disruption continues to change the role of technology across the workforce in the future. **Consequently, demand for ICT skills and qualifications is also expected to increase in the future**, with the strongest growth projected to be in postgraduate ICT qualifications.

Table 1: ICT employment forecast in selected occupations, 2014 to 2020

CIIER occupation grouping	2014	2020	Average annual growth
ICT management and operations	184,907	222,080	3.1%
ICT technical and professional	213,107	247,919	2.6%
Other ICT occupations	207,738	230,484	1.7%
Total ICT workers	**605,752**	**700,483**	**2.5%**

Source: Deloitte Access Economics (2015)

i. CIIER definition as used in ACS ICT Statistical Compendia 2008-2013. In order to maintain continuity with previous ACS published reports, the workforce analysis in this report draws upon definitions and nomenclature developed by the Centre for Innovative Industries Economic Research Inc. lead researcher, Ian Dennis FACS, and used in ACS ICT Statistical Compendia 2008-2013 and other CIIER analysis.

Coles

Coles operates traditional 'bricks and mortar' supermarket stores as well as an online retailing division. Investing in IT is a critical part of Coles' overall business strategy to increase efficiency and cost-effectiveness to meet customer needs.

Google Australia

Google's Australian office is one of the company's largest global engineering centres. The company employs a large team of engineers who work on product development and infrastructure.

Department of Immigration and Border Protection (DIBP)

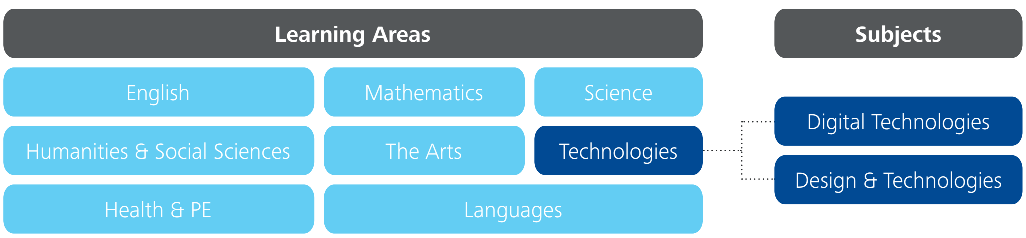
DIBP is the Federal Government department responsible for managing migration, humanitarian and citizenship policy and programs. DIBP has significant digital technology needs and requirements, as ICT is a critical business enabler supporting all aspects of the Department's activities.

Yet graduates with ICT qualifications have declined significantly since the early 2000s, and in recent years many Australian businesses have relied on workers from overseas and importing ICT skills to fill the gap. **More than 10,000 temporary skilled migration (457) visas have been granted annually to ICT workers over recent years**, and net arrivals of ICT workers were around 19,000 in 2013–14. Consultations with the business community suggest that workers from overseas are being relied upon for key technical capabilities such as software development and programming.

This raises an important question for the future: **where will the additional 100,000 ICT workers required by 2020 come from**? How can Australia ensure that its workforce is equipped with the ICT skills required to take advantage of the opportunities created by digital disruption?

The solution needs to be multifaceted: **government, businesses, education institutions and industry associations must all play a role in positioning the Australian workforce for the future**. Addressing these issues begins at the primary school education level, where computing skills and technical ICT capabilities should be included in the curriculum and taught to students from a young age. **The new Australian Curriculum, which includes a Technologies learning area (Figure 1), will be a significant step in the process** of teaching students to use computational thinking and information systems to define, design and implement digital solutions.

Figure 1: ICT learning areas in the Australian Curriculum, foundation to year 10



Source: Australian Curriculum, Assessment and Reporting Authority (2015)

The inclusion of the Technologies learning area in the curriculum is part of addressing the broader challenge of developing Science, Technology, Engineering and Mathematics (STEM) capabilities in Australia's workforce. **Not only do Australian students need to be digitally literate, but they are also required to be capable in building digital solutions for the problems of the future**. Results from the 2011 National Assessment Program show that currently, only 3% of Year 6 students frequently use ICT in schools for technical tasks. The new curriculum is designed to address this by teaching young students technical capabilities such as programming, coding and computer science.

At present, it is up to state authorities to advise schools of when and how the Technologies curriculum should be taught. **In implementing ICT education across Australian schools, comprehensive teacher education will be required** to assist teachers in developing effective teaching and learning practices using digital technology – particularly at the earlier year levels. An example of this is the online tool being developed by the Victorian Department of Education, which provides teachers with information on terminology, assessments, case studies and lesson plans for the new curriculum.

In summary, future directions in digital technology skills should include:

- **An increased national focus on growing Australia's ICT capabilities and skills in the workforce**, particularly among groups with the potential to significantly increase their ICT workforce participation (for example, women – who represent only 28% of the ICT workforce – and mature-aged employees, as well as workers displaced from other industries)
- **Federal and State Governments accelerating the development and implementation of the Technologies component of the Australian Curriculum**, focusing on equipping school students with critical technical computing skills and ensuring that school teachers are trained in delivering the curriculum
- **Higher education institutions promoting the strength and diversity of ICT-related study and career paths to students**, with the aim of increasing the future pipeline of ICT graduates, as well as developing more interdisciplinary opportunities between ICT and other subject areas
- **Businesses providing opportunities for employees to develop their ICT skills through on the job training**, workshops, upskilling courses and other business development initiatives, while also continuing to invest in ICT research and encouraging the integration of digital technology into wider business operations.

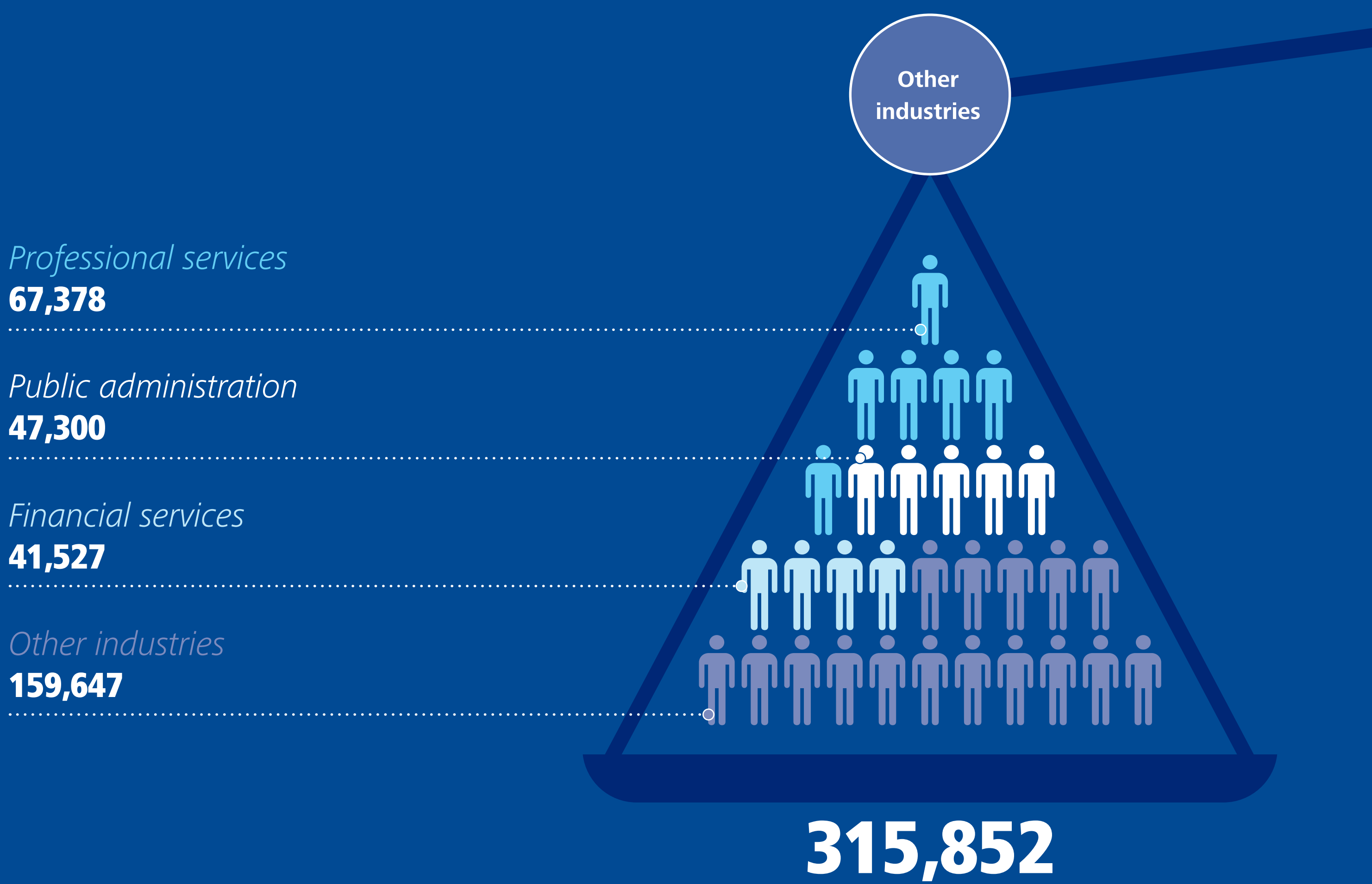
The rapidly growing digital economy means that ICT skills will play an increasingly important role in future economic growth. **Australia needs to ensure that its education system, policy settings and business practices are all working towards equipping our workers with the required technological skills**. This will ensure that the Australian workforce is well-placed to meet the future challenges associated with digital disruption.

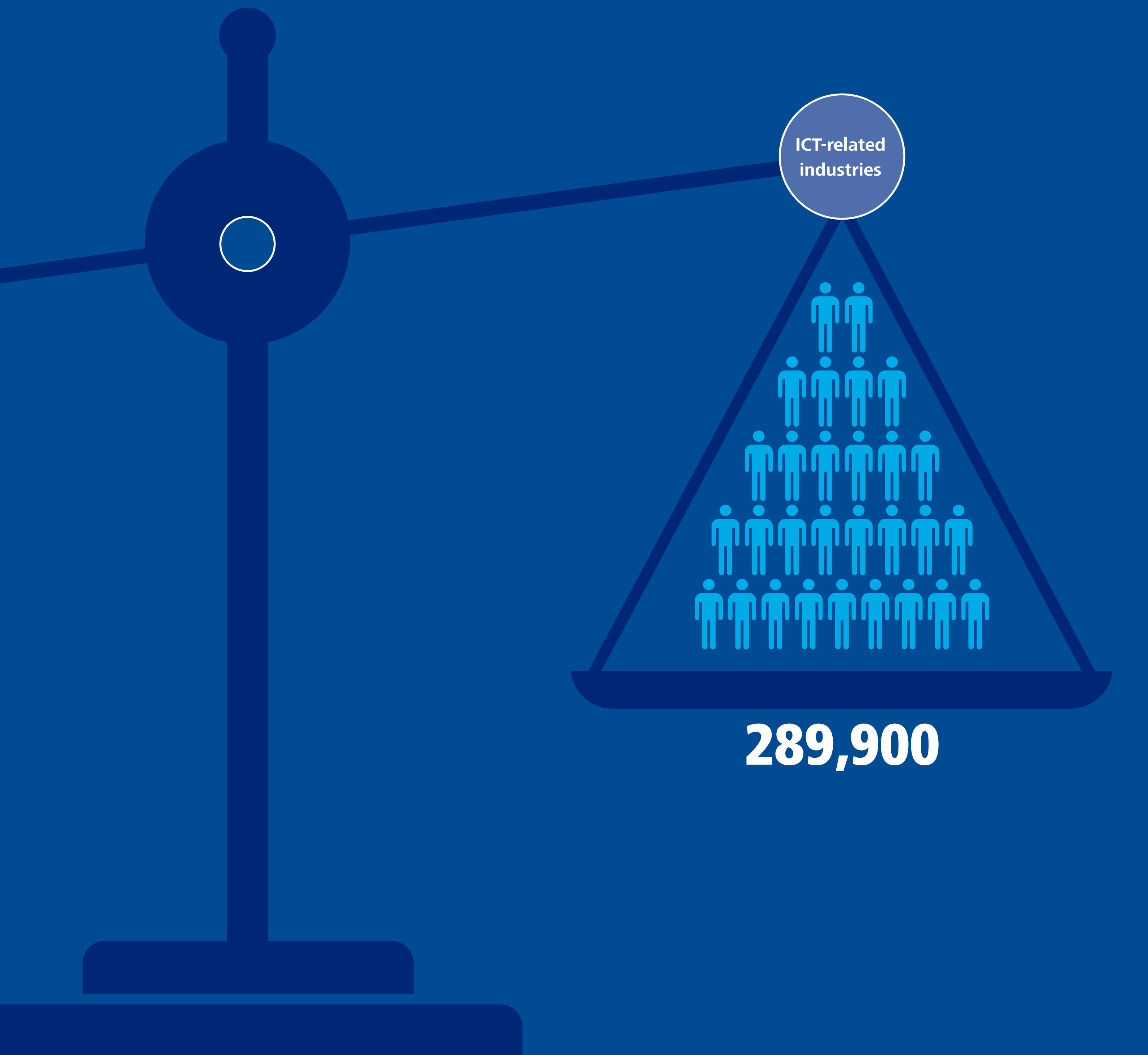
1

Digital economy snapshot

This chapter examines the current state of the Australian ICT workforce, including recent trends and the impact of digital disruption. It examines ICT occupations and industries, growth in the digital economy, the role of women in the workforce, the offshoring of ICT services and ICT research and development. It also includes international comparisons between the Australian digital economy and other countries.

▶ *ICT workers by selected industries, 2014*



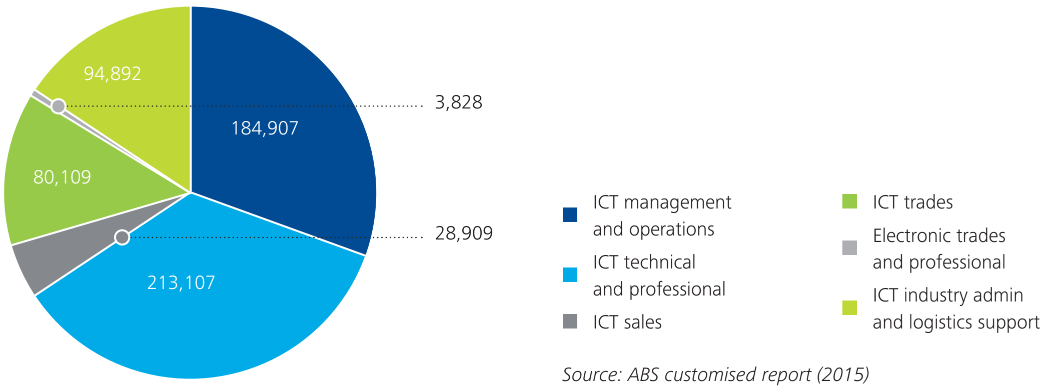

ICT-related industries
289,900

Digital disruption and the ICT workforce

There are around 600,000 ICT workers employed in the Australian labour force. Around half of these workers are employed in industries outside of ICT itself, such as other professional industries. Digital disruption in the Australian economy means that tasks that use and produce ICT are becoming increasingly embedded into the jobs of workers outside the ICT profession. As such, ICT skills will be critical in supporting innovation and productivity growth in the future.

A snapshot of the ICT workforce shows that there were around 600,000 ICT workers in Australia in 2014, representing approximately 5% of the total Australian labour force.[1] Around two-thirds of these workers were employed in management, operations, technical or professional roles (Chart 1.1, or Table A.4 for more details).

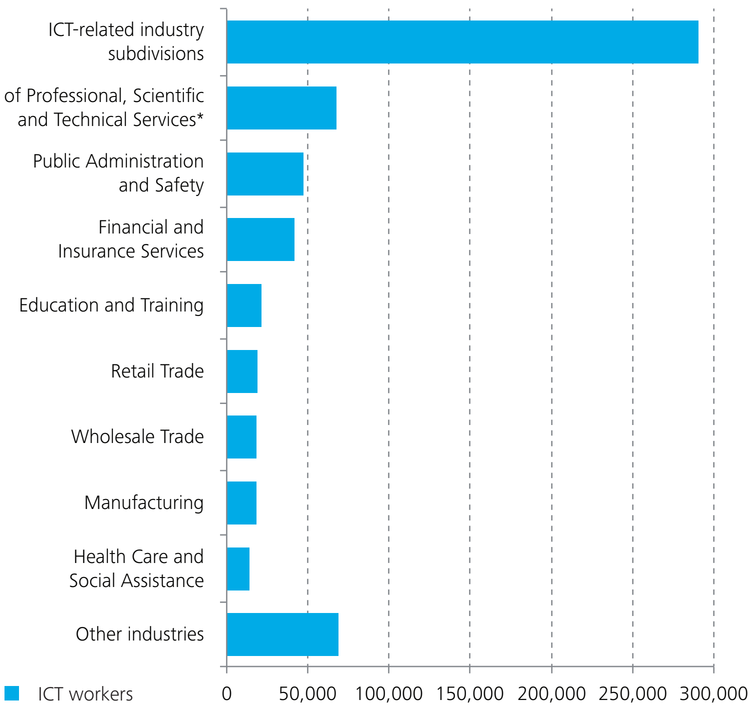
Chart 1.1: ICT workers by CIIER occupation groupings, 2014



Source: ABS customised report (2015)

Around 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, ICT workers can be found across a range of areas outside these ICT-related industries, with a particularly large presence in professional industries such as other professional services, public administration and financial services (Chart 1.2).

Chart 1.2: ICT workers by industry, 2014



** Excluding Computer System Design and Related Services which is separately identified as an ICT industry subdivision*
Source: ABS customised report (2015)

ICT workers are employed in a wide variety of organisations that may not have been viewed as traditional employers of ICT workers in the past. This reflects the increasing importance of ICT as the digital economy continues to grow, and the way digital disruption is changing the nature of occupations that a decade ago would not have involved using or producing digital technology. Technological developments associated with this digital disruption have resulted in ICT becoming increasingly accessible to non-ICT workers, changing the way ICT interacts with other business processes and operations.

The rapidly growing digital economy (discussed in more detail below) means that ICT skills have an increasingly important role in Australia's labour force. Greater technology use in the workforce means that Australian workers are increasingly required to possess strong skills in using and producing ICT. Deloitte's report *Digital disruption: Short fuse, big bang?* (2012) found that two-thirds of all industries in Australia will be significantly impacted by digital disruption by 2017 (Figure 1.1).[2] ICT skills will be critical in responding to these changes.

1. 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 previous ACS Statistical Compendiums. For a list of which occupations and industries have been classified as ICT workers, refer to Table A.3.
2. For more details, see Deloitte (2012) Digital disruption: Short fuse, big bang? <http://www2.deloitte.com/content/dam/Deloitte/au/Documents/Building%20Lucky%20Country/deloitte-au-consulting-digital-disruption-whitepaper-0912.pdf>.

Figure 1.1: Digital disruption map

Source: Deloitte Access Economics (2012)

Digital disruption is permeating through the economy, and this is changing the nature of many Australian occupations and industries. The use of ICT is becoming more integrated into the broader Australian workforce, and the production of ICT is no longer limited to traditional jobs such as manufacturing computer equipment or software development. Instead, producing ICT now involves new technology such as creating mobile applications, incorporating data analytics and developing cloud networks. Many of these tasks are now embedded into business processes rather than being exclusively performed by ICT workers.

As digital technology increases in prominence more broadly across the Australian economy and workforce, trends and growth in the digital economy are affecting more than just traditional ICT workers or graduates from traditional ICT-related courses.

Many graduates with ICT-related qualifications are going into roles that are not traditional ICT occupations, with the 2011 Census reporting that 47% of all workers who studied information technology courses work in other occupations. These span a range of positions including advertisers, marketers, engineers, accountants, bookkeepers and other professionals.

In the other direction, the 2011 Census found that 43% of workers in ICT occupations studied courses other than information technology or engineering – in particular, almost 20% of ICT workers had studied degrees in commerce and management (discussed below in Chapter 2). This indicates that the skills for a successful ICT worker can come from a range of disciplines, particularly those exposed to programming, critical thinking and creative design skills.

Given the rising prominence of digital technology, the breadth of ICT skills across the Australian economy is increasing. ICT workers are going into a variety of industries, and digital disruption is resulting in increased ICT use within traditionally non-ICT occupations.

In 2010, the OECD estimated that around 22% of the Australian workforce were intense users of ICT in their work, with a significant majority of these roles being non-ICT occupations such as engineers, accountants, lawyers, human resources and marketing.

In fact, for many businesses outside traditional technology industries, ICT is becoming an increasingly important component of their business strategy. Katrina Anderson, Human Resources Manager – Digital at Coles, recognises the importance of ICT for driving innovation within the business. As such, the company's employees are encouraged to find new ways of applying ICT to increase the quality of customer service across the business, and staff often rotate between the digital department and other areas in order to gain exposure to a range of business activities (for more details, see the Coles box below).

Coles

As one of Australia's largest supermarket chains, Coles employs around 100,000 team members across Australia. The company operates traditional 'bricks and mortar' stores as well as an online retailing division, Coles Online.

Katrina Anderson, Human Resources Manager – Digital at Coles, states that a range of skills required in the IT (Digital) function are currently in short supply, including 'project management, solutions architects and security experts. Our customers trust us with their personal information, which is why online security is a particular priority for Coles'.

Like most large Australian companies, Coles is determined to increase the number of women in leadership positions within the IT (Digital) function. Female representation at Coles, including in leadership roles, continues to increase.

Investing in IT is a critical part of Coles' overall business strategy to increase efficiency and cost-effectiveness to meet its customer needs. Katrina observes that this is not limited to the IT department; rather, 'all team members are encouraged to contribute to innovation and find smarter ways of working by incorporating IT into their roles'.

One example of this is in the role of in-store shoppers – team members who collect orders for Coles Online customers. 'Our in-store shoppers now have iPads on their trolleys with pictures of the products in the customer's order. As text can be read differently or is harder to understand, pictures on iPads make the task easier for team members.'

The notion that all team members, even those not specifically working in IT roles, can utilise digital technology in their roles is further developed at Coles by encouraging team members to rotate between areas within the business. This means that the company develops good generalist team members with a broad range of leadership, financial, people and technical skills. It begins at a graduate level and continues through a team member's career pathway – Katrina notes that 'we have a graduate from HR doing a rotation in Digital because she wants to understand how, as an HR practitioner, she can apply efficiencies to HR processes in the future. We also have an IT graduate working within the HR team, applying their knowledge to analyse gaps and opportunities in the business using statistics and data analytics'.

These rotations are encouraged because they enable team members to exploit crossovers between IT (Digital) and other areas of the business. This allows Coles team members across the company to find new ways of using IT to improve business processes and more efficiently serve their number one focus: the customer.

Clearly, digital disruption is not just affecting the ICT sector. In light of these trends, Australia needs more ICT skills in the workforce and the broader economy, in order to support innovation and productivity growth in the future. By thoroughly and continuously assessing current and future ICT skills needs in the Australian economy, and ensuring that policy settings and the education system are sufficiently equipping workers with the necessary ICT skills, we can ensure that Australia is well-placed to meet future challenges in the face of digital disruption and a rapidly growing digital economy. These issues will be discussed further in Chapters 2 and 3.

Contribution of the digital economy

Australia's digital economy was estimated to have contributed around $79 billion to 2013–14 GDP in Deloitte's report *The Connected Continent II: How digital technology is transforming the Australian economy* (2015), representing around 5% of total Australian GDP over this period.

The economic contribution of the internet and digital technologies can be difficult to estimate, particularly given the changes generated by digital disruption within Australian businesses across a variety of industries. In Deloitte's report *The Connected Continent II: How digital technology is transforming the Australian economy* (2015), the digital economy in Australia was estimated to have contributed $78.8 billion to GDP in 2013–14, representing 5.1% of total Australian GDP.[3]

This estimate was calculated by examining the economic contribution of the internet and related digital technologies in the Information, Media and Telecommunications (IMT) industry; the rest of the market sector including goods and services produced in other industries; and the non-market sector including education, health and government (Table 1.1).

Table 1.1: Value-added estimate of the economic contribution of the internet and digital technologies, 2013–14

	Information, Media and Telecommunications	The rest of the market sector	Non-market sector	Total
Total value added	$43.5 billion	$1,160.8 billion	$256.0 billion	$1,460.3 billion
Share of GDP	3%	74%	16%	94%
Internet and digital technologies economic contribution	**$13.0 billion**	**$51.7 billion**	**$14.1 billion**	**$78.8 billion**
As a share of the total economic contribution of the internet	*16%*	*66%*	*18%*	-
As a share of GDP	*0.8%*	*3.3%*	*0.9%*	*5.1%*

Source: Deloitte Access Economics (2015)

The analysis focused specifically on the contribution of internet and internet-related technologies, a measure that is similar to but not directly comparable with ICT economic activity.[4] However, it provides an indication of how critical the internet and digital technologies are in Australia's economy – which is closely related to the importance of the roles and contribution of ICT workers more broadly.

There has been significant growth in the Australian digital economy over recent years. The $79 billion contribution of the internet in 2013–14 compares with an estimate of $50 billion in 2011, and the rapid growth is expected to continue in a globally-connected digital world. As the digital economy continues to grow, it will become increasingly important to equip Australian workers with ICT skills to further develop innovation and productivity growth in the economy.

3. For more details, see Deloitte (2015), The Connected Continent II: How digital technology is transforming the Australian economy <http://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-economics-connected-continent-ii-2015-300315.pdf>.

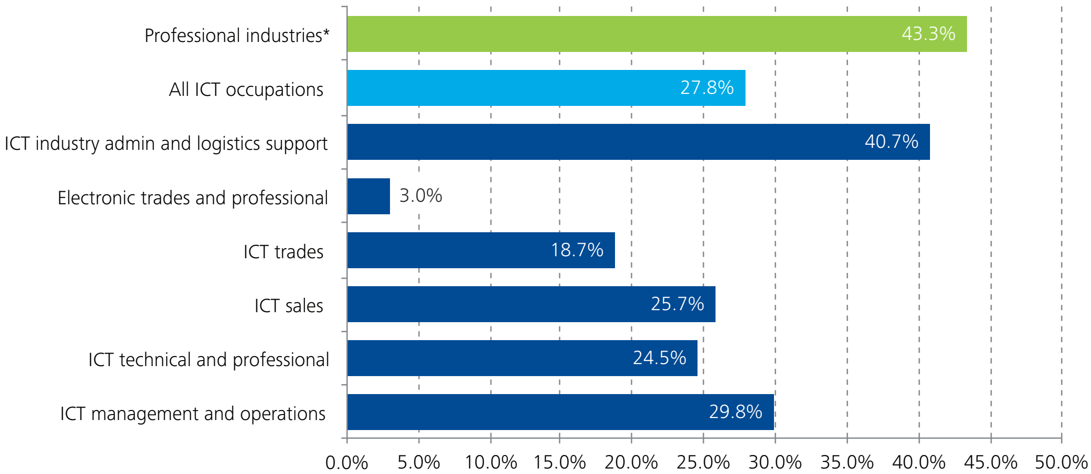
4. For example, ICT includes some communications, electronics and sales positions that are not internet related and are therefore not included as part of the economic contribution analysis in the previous report.

Women in the ICT sector

Women are significantly underrepresented in the Australian ICT sector compared to the wider professional workforce, comprising around one-quarter of all ICT workers. There is also a significant income gap across the ICT workforce, with women on average earning 20% less than men. Other forms of gender discrimination are also apparent in the sector.

Despite the increasing importance of ICT in the Australian economy and the workforce changes associated with digital disruption, women are still significantly underrepresented in the ICT sector relative to the rest of the professional workforce. 28% of all Australian ICT workers are women, compared to 43% of all individuals working in professional industries (Chart 1.3). This gender imbalance reflects the fact that some of the main occupations within the ICT workforce have relatively low female representation – for example, women only represent around 20% of all software programmers, ICT managers and support technicians.

Chart 1.3: Share of women in ICT occupations, 2014



**Includes Financial and Insurance Services, Information Media and Telecommunications and Professional, Scientific and Technical Services*
Source: ABS cat. 6291.0 (2015) and customised report (2015)

There are a number of reasons behind the gender imbalance in the ICT workforce, including a narrow image of what it means to work in a technology-oriented field and the perception of a lack of flexibility in the workplace. The fact that the industry is already male dominated could also be a contributing factor deterring women from entering the ICT workforce. Ian Oppermann, an ICT industry expert, notes that in addition to a shortage of women taking up ICT employment, the profession also struggles to retain its female staff (for more details, see the box below).

Women and skills in the ICT industry

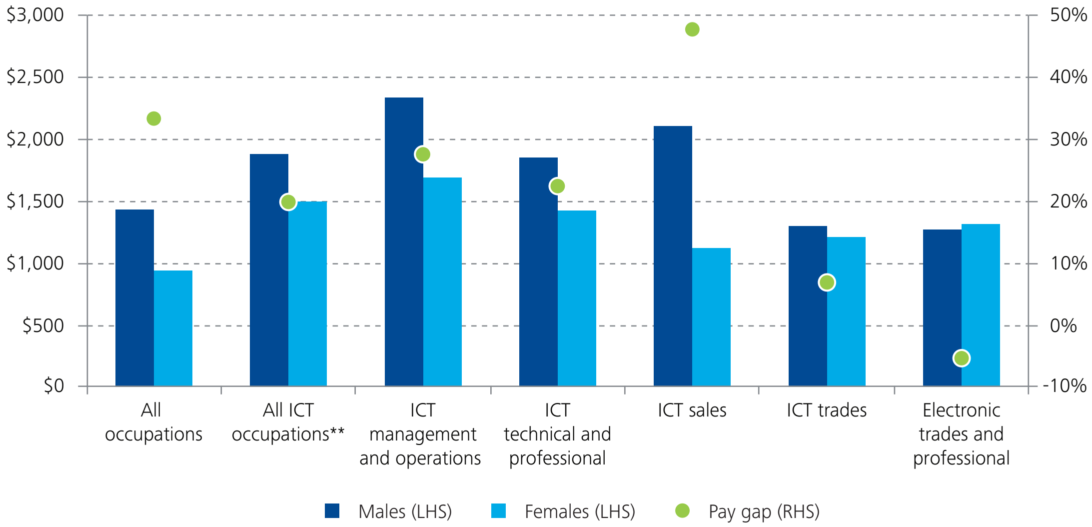
Ian Oppermann is a thought leader in the digital economy area and an expert in the ICT sector, with more than 20 years' experience in the industry. In his experience leading organisations in the ICT industry, Ian has generally perceived few issues in sourcing ICT graduates for entry-level positions. However, 'while formal qualifications are easy to come by, it is a struggle to find new staff with the right experience', and Ian notes that workers with a few years' experience, transferable skills and a broader understanding of system infrastructure as well as an understanding of computing language are more highly valued but in shorter supply. He says that ICT skills issues are part of a broader issue in Australia where talented young graduates with ICT or engineering backgrounds find it difficult to develop technical career paths in Australia due to a lack of a technology company ecosystem, which encourages people overseas.

Ian also identifies a significant shortage of women in the ICT research workforce. He believes that 'cultural stereotypes, a shortage of strong female role models in the industry and gender divides in research and development' have a greater influence on the number of women taking up ICT research employment rather than what is specifically taught in schools. Compared with other sciences such as astronomy and material sciences, ICT research also struggles to retain its female workforce. Ian identifies a gap in the understanding of the 'higher purpose' associated with ICT, and its potential 'to change the world through providing equal opportunities to society (for example through the NBN), or through the development of cutting-edge technology'. Ian believes that communicating this purpose more broadly will contribute to retaining the industry's female staff.

The gender imbalance is also reflected in the incomes paid to ICT workers. 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 1.4, or Table A.14 for more details). However, income inequality among ICT workers is lower than income inequality across the entire Australian workforce, where females on average earn 34% less than their male counterparts.[5] Nonetheless, an earnings differential of 20% is a significant gap, which suggests that the ICT sector has some way to go with respect to improving income equality for women.

5. Note that these comparisons are based on average total earnings by occupation and gender, and as such the pay gaps may partly be picking up the fact that more women have part-time roles. Nonetheless, data from the 2011 Census show that gender pay gaps also exist across the ICT occupations for full-time employees only. On this measure, average earnings for women in the ICT workforce are 7% lower than men, compared to an average pay gap of 14% across all occupations. The CIIER ICT occupation groupings with the largest gender pay gaps for full-time workers are ICT sales (22%), ICT technical and professional (14%) and ICT management and operations (10%).

Chart 1.4: Average total weekly earnings of ICT occupations by gender, May 2014



**Includes full-time and part-time workers*
*** Excludes ICT industry admin and logistics support for which breakdowns are unavailable; electronic trades and professional data is for all industries*
Source: ABS cat. 6306.0 (2015)

Survey results generally suggest that other forms of gender discrimination are prevalent across the ICT workforce. The ACS Employment Survey in 2014 found that 42% of female respondents had encountered discrimination when applying for ICT positions, with around half of these indicating that the discrimination was based on gender. In the 2012 ACS Women's Board Survey, almost 40% of respondents noted that a male-dominated working environment had significantly affected their career advancement.

Trade in ICT services

Australia is both an exporter and importer of ICT services, with total trade flows in 2014 of almost $5 billion in this area. Over recent years, there has been an increase in the offshoring of computer services in particular, with a rise in computer services imports occurring between 2012 and 2014. Australian goods imports also tend to have a higher share of ICT inputs embedded into them compared to exports.

Trade in ICT services totalled almost $5 billion in 2014, comprising $2.9 billion in imports and $2 billion in exports. Within the category of ICT services, trade in computer services such as data processing, IT help desk and hardware and software consultancy represents more than 70% of total trade flows both in and out of Australia (for more details, see Table A.17 and Table A.18).

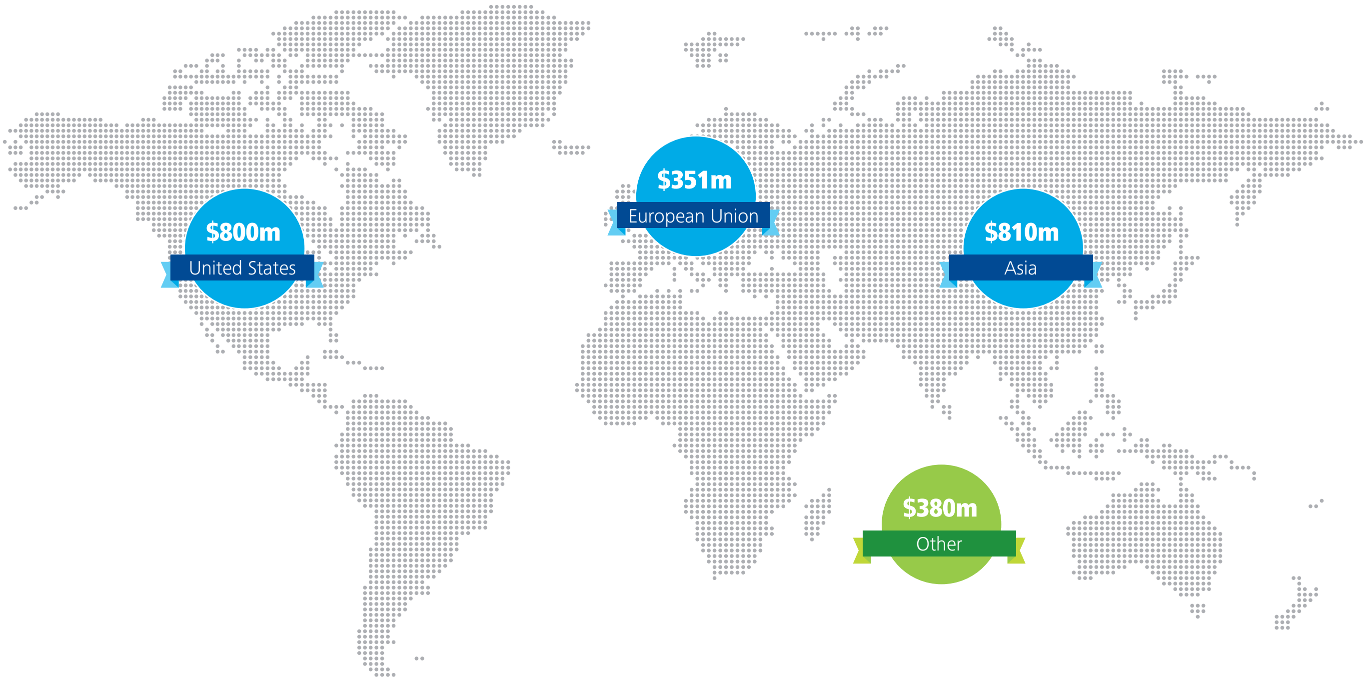
Exports and imports of computer services have generally tended to be quite balanced since 2000, with both flows gradually rising in the 2000s before levelling out towards the end of the decade. However, the past couple of years have seen a rise in computer services imports, which increased by almost 50% between 2012 and 2014 (Chart 1.5). This indicates that there has been an increase in the offshoring of computer services over recent years, which could be associated with more companies choosing to locate their IT functions overseas.

Chart 1.5: Trade in computer services, 2000 to 2014

Source: ABS cat. 5302.0 (2015)

Returning to the broader category of ICT services, trade data from 2013 shows that one-third of ICT services imports come from Asian countries, roughly the same share as import flows from the United States (Figure 1.2). In particular, one of the faster-growing sources of ICT services imports is India, whose import share almost doubled over five years to reach close to 10% of Australia's total imports of ICT services in 2013.

Figure 1.2: Imports of ICT services by region, 2013



Source: ABS cat. 5368.0 (2015)

Beyond trade in ICT services, OECD data suggests that Australia also has a sizeable trade deficit in ICT goods (for more details, see Table A.25). ICT is also embedded into goods imported and exported across all industries in the economy. For example, manufactured transport equipment imported into Australia could include a computer systems design or software development component. In comparison, the ICT intensity of the inputs used to produce commodity exports is likely to be relatively lower.

An analysis of the industry breakdown of Australian goods imports and exports, combined with an assessment of the average ICT intensity of the intermediate inputs used by Australian industries, suggests that the ICT input share of goods imports was around 7% in 2013.[6] In comparison, the ICT input share of goods exports was lower at around 4%, indicating the ICT intensity of Australia's goods trade is greater on the import side.

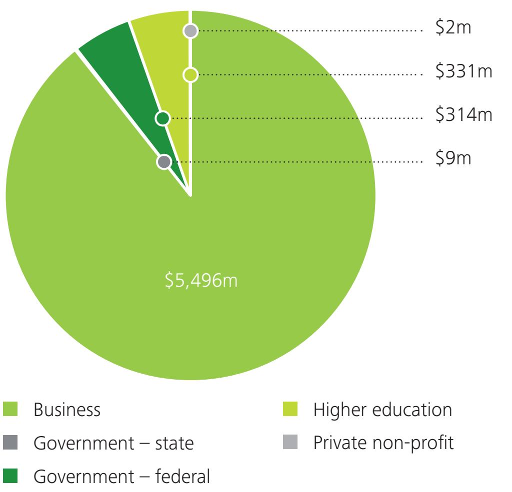
6. The intermediate inputs categorised as ICT inputs are 'Computer Systems Design and Related Services' and 'Professional, Scientific and Technical Services' under the ABS's classifications of intermediate use. While the second category may include some inputs that are not technically ICT-related, these categories provide a good basis for comparison between the ICT intensity of goods imports and exports.

ICT research and development

ICT research in Australia is largely business-led, in contrast to other areas of research and development. One reason for this is that ICT research is one of the few areas from which individual companies across most industries can benefit, as there are users and producers of ICT across the entire Australian economy.

The majority of research and development in the ICT field in Australia is conducted by businesses. Australian businesses spent around $5.5 billion on ICT research and development in 2011–12, representing around 90% of total ICT research spend (Chart 1.6, or Table A.15 and Table A.16 for more details). Business expenditure on ICT research has grown rapidly over recent years, at an average annual rate of 10% since 2007–08.

Chart 1.6: Expenditure on ICT research and development, 2011–12



Sources: ABS cat. 8104.0 (2013), 8109.0 (2014), 8111.0 (2014)

Australian businesses spend a relatively large share of their research and development funds on ICT research, which comprises around 30% of businesses' research expenditure. In contrast, expenditure on ICT research and development by Australian government, higher education and private non-profit organisations represents less than 5% of their overall research spend. The fact that ICT research is largely business-led stands in contrast to other areas of research and development in Australia – for example, medical research is primarily funded by higher education organisations, while the government largely leads research into agriculture.

This could point to two factors. First, the economic and social importance of ICT has emerged over a period where higher education funding has declined and government budgets have been tightened. Given that these organisations have already committed funding or dedicated research facilities in other fields of research, it is not surprising that their priorities for research and development expenditure are in other areas. This means that businesses are required to fill the gap of investing in ICT research and development if this is necessary for growth.

Second, ICT is one of the few general use technologies where individual companies across most industries can invest in research and development and obtain a return on their investment, as digital disruption creates users and producers of ICT across the entire Australian economy. While other major areas of research such as medicine and agriculture are mainly for their respective industries, increased efficiency in the use and production of ICT can benefit a wide range of industries. As such, it makes sense that ICT research is largely business-led – because it is a profitable action for businesses in a range of industries to take.

Australia's ICT strengths and weaknesses

Compared with other developed countries, Australia is a high-level user and adopter of ICT, with comparatively high rates of mobile broadband penetration and business adoption of ICT for commercial practices. However, Australians are relatively low-level producers of ICT, as the size of Australia's ICT workforce is around the middle of the pack and ICT's share of Australian research expenditure is relatively low.

The size of Australia's ICT workforce as a share of total jobs in the economy is around the middle of the pack when compared to other developed countries. While data from the OECD suggests that the share of ICT specialists in the workforce is smaller than a number of Nordic and North American countries, Australia outranks several other European countries on this measure (Table 1.2, or Table A.19 and Table A.20 for more details).[7] This is also the case for the share of ICT-intensive occupations in each economy's workforce.

While Australia is around average for the size of its ICT workforce and the share of ICT-intensive occupations in the economy, the adoption of ICT by Australian businesses for commercial practices ranks highly compared to other developed countries. A relatively high share of 38% of Australian businesses engage with customers through e-commerce and online sales, while around three quarters of businesses have an online presence through a website or homepage (Table 1.3, or Table A.27 and Table A.28 for more details).

Table 1.2: Share of ICT specialists and intensive users in the total economy, 2010

	Specialists (narrow)	Intensive occupations (broad)
Sweden	5.4%	26.5%
Norway	4.7%	24.1%
Finland	4.5%	25.5%
Denmark	4.4%	27.3%
Canada	4.4%	21.2%
United States	4.0%	20.3%
Australia	***3.6%***	***22.1%***
Germany	3.5%	22.5%
United Kingdom	3.3%	28.1%
France	3.1%	20.7%
Spain	3.1%	19.5%
Italy	3.1%	20.4%

Source: OECD, Information Technology Outlook (2010)

Table 1.3: E-commerce by country

	Share engaged in sales via e-commerce (2012)	Share of businesses with website (2013)
New Zealand	47%	78%
Australia	***38%***	***74%***
Denmark	30%	92%
Norway	28%	79%
Germany	26%	84%
Sweden	26%	89%
Japan	25%	89%
United Kingdom	22%	82%
Finland	19%	94%
Canada	19%	78%
Korea	15%	60%
Spain	14%	68%
France	14%	65%
Italy	8%	67%

Source: OECD, ICT Database (2014)

Complementing the large share of businesses adopting e-commerce practices is the significant take-up rate of mobile broadband in Australia. For every 100 persons in Australia, there are around 114 subscriptions to mobile wireless broadband, ranking the country among the highest in the world for mobile broadband penetration (Table 1.4, or Table A.29 for more details). This means that a significant share of Australian residents have access to mobile internet technology, and are able to conveniently engage with the large share of Australian businesses who have adopted online presences.

Table 1.4: Mobile wireless broadband penetration, 2013

	All mobile wireless broadband technologies (subscriptions per 100 inhabitants)
Finland	123.3
Australia	*114.4*
Japan	111.8
Korea	103.8
United States	100.7
New Zealand	85.9
United Kingdom	77.2
Spain	68.5
Italy	65.3
France	55.9
Canada	53.3
Germany	45.1

Source: OECD, Broadband Portal (2014)

Despite the importance of ICT in Australian businesses' operations, the share of research and development expenditure dedicated to ICT in Australia is relatively low compared with other developed countries. As discussed above, ICT research in Australia is primarily business-driven, with Australian companies dedicating a sizeable share of their research expenditure on the ICT area. However, overall ICT research and development accounts for only 10% of total research and development in Australia, which is significantly lower than the share of funding allocated to ICT research across other developed countries (Table 1.5, or Table A.21 for more details).

Table 1.5: ICT research and development expenditure by country

	Share of total research and development*	Year**
Korea	54%	2013
United States	32%	2011
Singapore	30%	2011
Canada	27%	2013
New Zealand	19%	2011
Japan	18%	2013
Italy	18%	2012
France	17%	2012
United Kingdom	16%	2012
Spain	15%	2012
Germany	12%	2012
Australia	*10%*	*2011*

** ICT R&D calculated as the sum of R&D in the following industries under ISIC Rev. 4 classifications: D261, D262, D263, D582, D61, D62, D63.*

*** Latest available year*

Source: OECD, STAN R&D Expenditures in Industry (2015)

This could reflect the fact that a significant share of research and development in Australia is focused on other industries, such as mining and agriculture. However, given the increasing importance of digital technology in the Australian economy, there is considerable scope and incentive for increasing domestic expenditure on ICT research and development. Future research in the ICT area will be particularly important as Australian businesses are large users and producers of ICT, and ICT plays a significant role in the overall Australian economy. ICT research and development therefore has the potential to contribute considerably to future productivity growth in Australia.

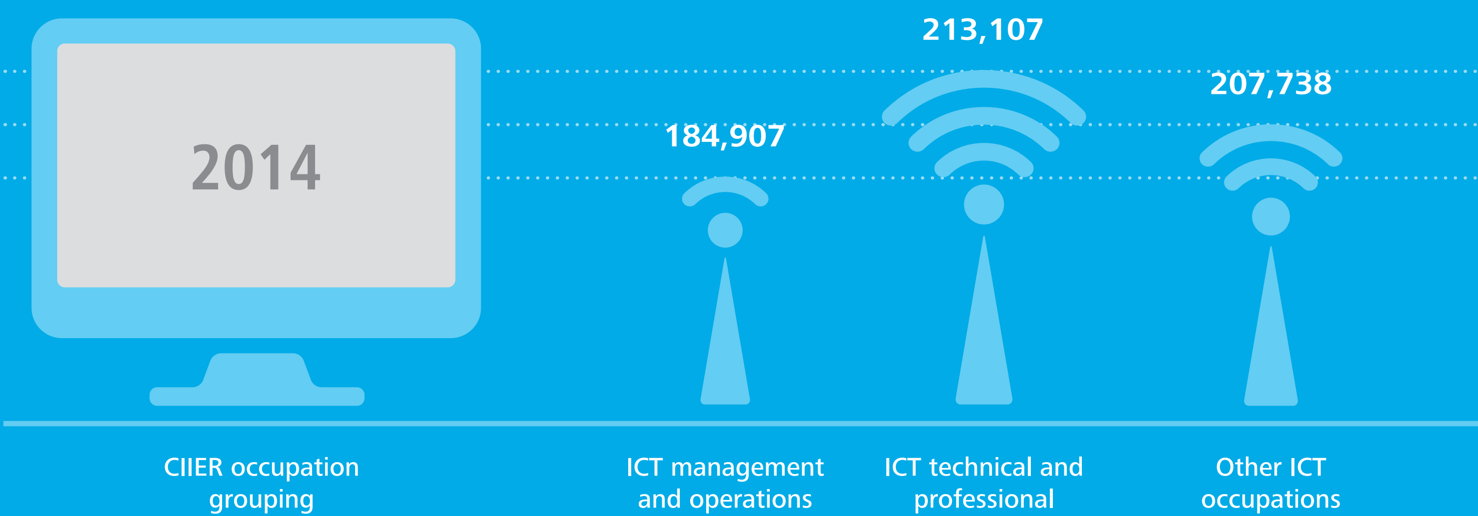
7. The OECD's measure of ICT specialists is roughly consistent with our measure of ICT workers. However, the figures are not completely aligned due to (a) some small definitional differences on occupations included and excluded in the categories, and (b) timing differences as the OECD data represents a snapshot taken in 2010. The OECD data nonetheless provide a good basis for comparing the size of the ICT workforce across countries.

2

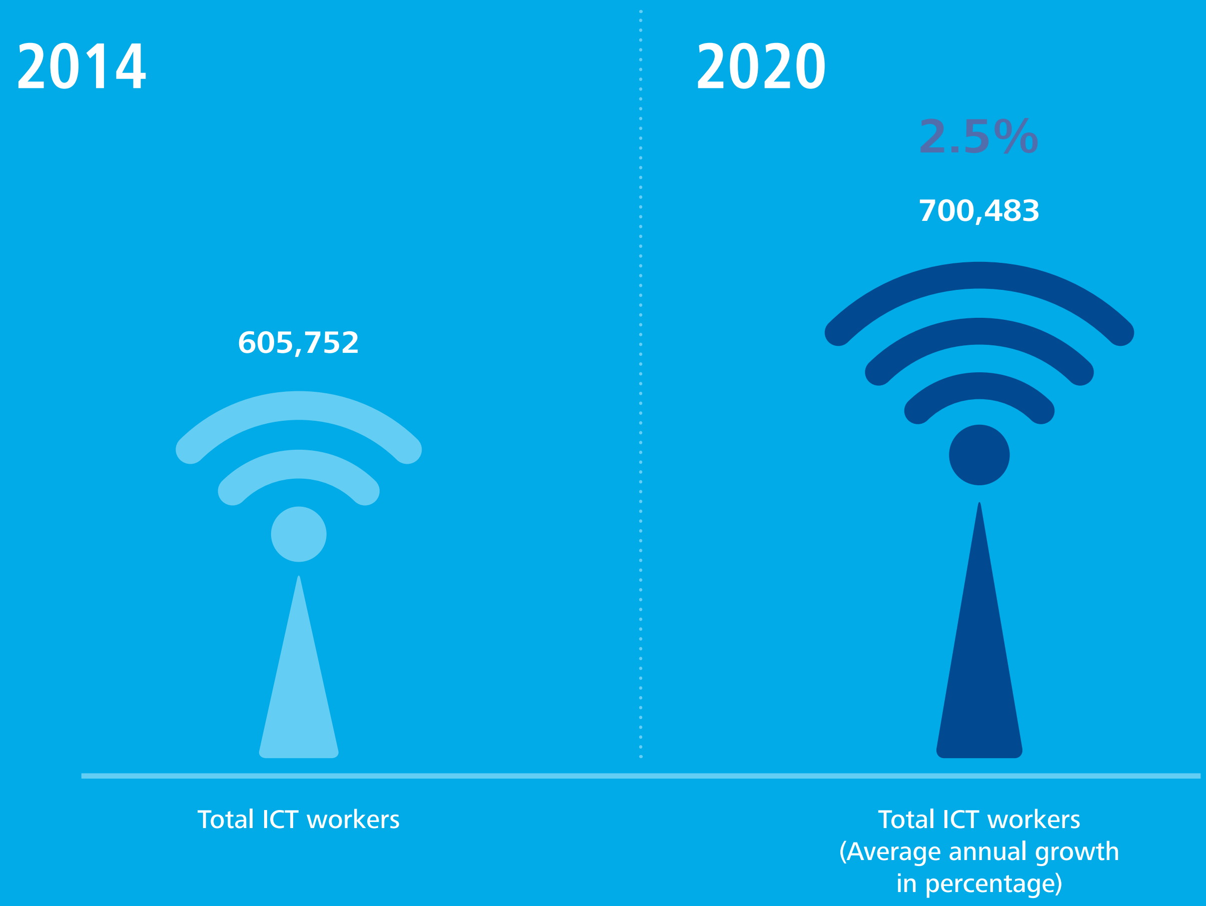
Occupational analysis

This chapter analyses the current and expected labour force developments for the ICT sector. As a part of this process, the chapter considers the demand for different occupations using Deloitte Access Economics' workforce forecasting model. It also considers ICT-related education, qualifications and migration, which are key drivers of the supply of ICT workers.

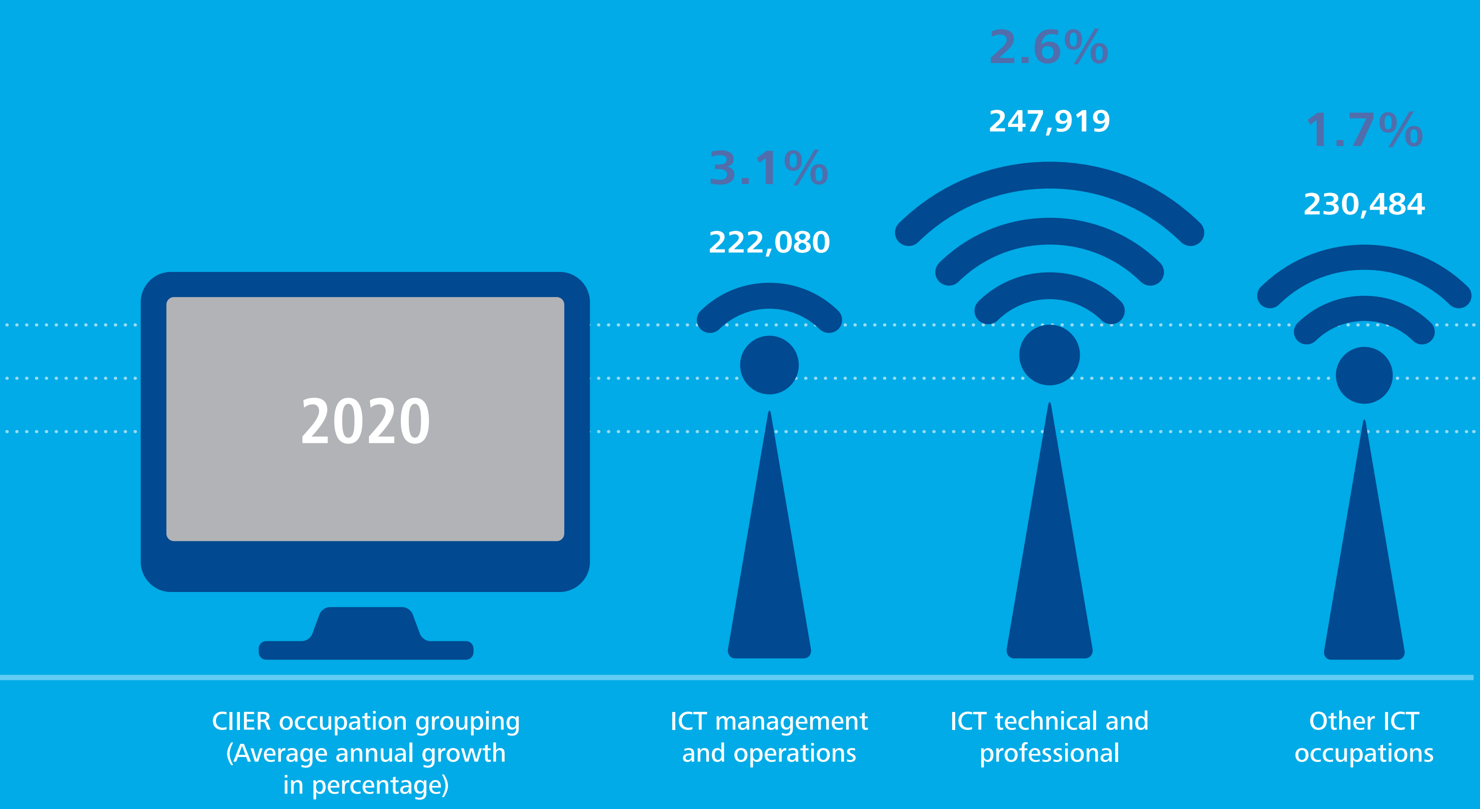
▶ *ICT employment forecast by occupation, 2014 to 2020*



Source: Deloitte Access Economics (2015)



2014
2020
2.5%
700,483
605,752
Total ICT workers
Total ICT workers
(Average annual growth
in percentage)



2.6%
247,919
3.1%
222,080
1.7%
230,484
2020
CIIER occupation grouping
(Average annual growth
in percentage)
ICT management
and operations
ICT technical and
professional
Other ICT
occupations

Demand for ICT workers

Despite evidence of some offshoring of ICT work occurring, the demand for ICT workers remains strong. The role of ICT workers in facilitating the increasingly important digital economy means that forecast employment growth for the sector is stronger than the economy as a whole. Growth in the ICT sector is likely to be strongest for technical, professional, management and operational occupations. This reflects the integration of ICT workers across a broad range of industries, particularly professional services.

The demand outlook for the ICT sector remains robust. In Deloitte's thought leadership piece *Positioning for prosperity? Catching the next wave* (2014), the ICT sector was identified as a 'slipstream star', a sector uniquely positioned for growth with strong global opportunity meeting Australian advantage.[8] The ICT sector is an important catalyst for growth in other sectors and will benefit from the increasingly digital and data driven nature of economies worldwide.

Future demand for ICT occupations

As discussed in Chapter 1, there are many more people who can be classed as ICT workers than there are people working in the Information, Media and Telecommunications industry designated by the ABS. The analysis of the ICT workforce in Chapter 1 found that there were around 600,000 people working in ICT relevant occupations, amounting to around 5% of the Australian labour force.

Looking forward, solid jobs growth is expected for the ICT sector over the coming six years. Overall employment in the ICT sector is expected to grow by 2.5% per year over the next six years to 2020 (Table 2.1). This is higher than forecast growth in employment for the economy as a whole, which is forecast to grow by around 1.6% over the same period. The outperformance of the ICT sector reflects its importance in Australia's workforce and its role in enabling the digital economy.

8. For more details, see Deloitte (2014), Positioning for prosperity? Catching the next wave <http://www2.deloitte.com/content/dam/Deloitte/au/Documents/Building%20Lucky%20Country/Deloitte_au_business_positioning_for_prosperity_2014.pdf>. Note that the ICT sector as defined in the 2014 report is not directly comparable with the definition of the ICT workforce applied in Table A.3 and throughout this report, which is primarily based on ABS occupational classifications at the 4-digit ANZSCO level.

Within the ICT workforce, jobs growth is predicted to be strongest for ICT management and operations (3.1% average annual growth), ICT technical and professional workers (2.6% average annual growth) and ICT sales workers (3.3% average annual growth). ICT workers in the trades fields are expected to see more modest growth; 1.4% p.a. for ICT trades and 0.5% p.a. for electronic trades and professionals. Finally, employment in the ICT industry admin and logistics support employment group is expected to see reasonably healthy growth of 1.6% p.a.

Table 2.1: ICT employment forecast by occupation, 2014 to 2020

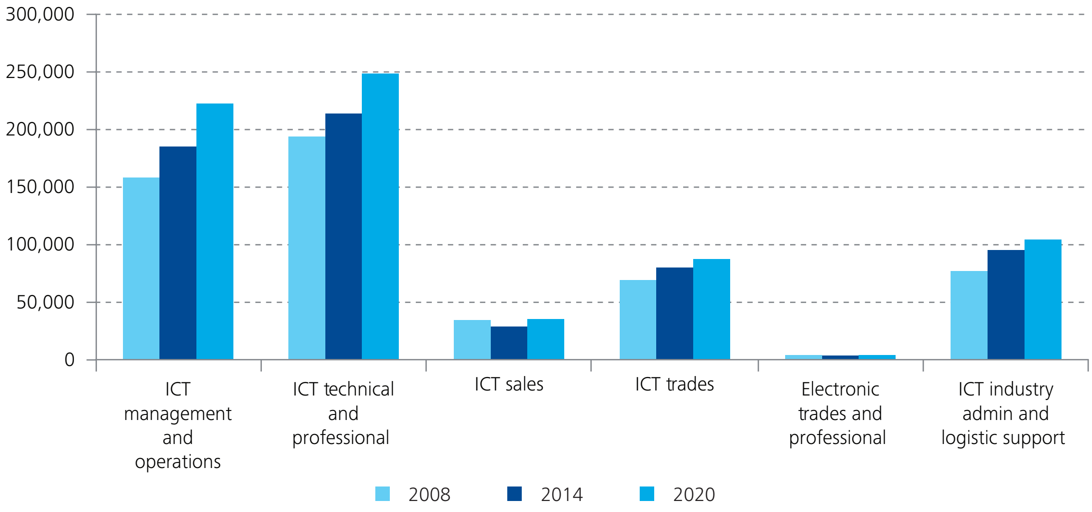
CIIER occupation grouping	2014	2020	Average annual growth
ICT management and operations	184,907	222,080	3.1%
ICT technical and professional	213,107	247,919	2.6%
ICT sales	28,909	35,193	3.3%
ICT trades	80,109	87,148	1.4%
Electronic trades and professional*	3,828	3,939	0.5%
ICT industry admin and logistics support*	94,892	104,205	1.6%
Total ICT workers	**605,752**	**700,483**	**2.50%**

** 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 (2015)

The fact that ICT management, operations, technical and professional roles are expected to drive employment growth in the ICT workforce over the near future is consistent with the trend observed over the past six years. Between 2008 and 2014, these particular ICT occupations accounted for almost 70% of total growth in the ICT workforce (Chart 2.1). This reflects the integration of technical and operational ICT workers across a broad range of sectors outside of traditional technology industries (such as the professional services industry) – a trend which is expected to persist as the digital economy grows and digital disruption continues to change the way different occupations use and produce technology.

Chart 2.1: Historical and forecast ICT employment, 2008 to 2020



Importantly, this trend towards continued integration of ICT into business operations means that the definition of ICT workers and the ICT requirements of Australian businesses are likely to expand further over the coming decade. For example, mining that is currently done on-site may be done remotely in the future, which could mean that some traditional engineering roles will merge with ICT-related positions. Because of these trends, the projected growth in demand for ICT workers may be understated as the forecasts assume that the role of ICT in the future will be constrained to similar functions as are performed now.

Future demand for ICT qualifications and skills

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, demand for qualifications depends not only on the employment forecasts above, but also on other skills and market considerations. These considerations include the propensity for different occupations to hold certain education levels and forecast retirement rates.

Overall skills demand for the ICT workforce is forecast to increase at a healthy rate of 3.4% per annum over the six years to 2020 (Table 2.2, or Table A.6 for more details). This is higher than the forecast growth in ICT employment of 2.5% per annum, resulting in more than one million ICT-related qualifications forecast to be demanded by 2020. The propensity for workers to hold more than one qualification means that the projected demand for qualifications exceeds the projected demand for employees (in Table 2.1). A worker with a postgraduate degree who also completed an undergraduate degree, or a worker who has finished a Certificate I course who then goes on to study and graduate from university, are examples of ICT workers holding multiple qualifications.

Table 2.2: Total qualifications held by ICT workers, 2014 to 2020*

	2014	2020	Average annual growth
Postgraduate	169,508	216,922	4.2%
Undergraduate	360,459	440,523	3.4%
Advanced dip/ diploma	157,845	190,311	3.2%
Certificate III and IV	111,235	134,039	3.2%
Certificate I and II	52,863	59,496	2.0%
Total	**851,910**	**1,041,291**	**3.4%**

** One person may hold multiple qualifications*
Source: Deloitte Access Economics (2015)

The forecasts suggest that higher educational levels and qualifications will be associated with the strongest future growth in demand. The highest growth rate in demand for ICT qualifications is forecast for postgraduates, with demand forecast to grow at 4.2% annually over the six years to 2020. Strong demand growth for postgraduate ICT qualifications reflects the broader 'skills deepening' trend in the labour market; that is, a growing propensity towards holding higher qualifications. On the other end of the spectrum, the increase in demand for Certificate I and II ICT qualifications is more subdued at 2.0% p.a.

Supply of ICT workers

The ICT field of education has struggled to attract domestic students. Despite a growing tertiary market, ICT enrolments and completions at the tertiary level are well below the levels seen in the early years of the 2000s. Employers of ICT workers have been able to source workers from other fields of education, such as engineering. Vocational education outcomes are steadily improving in terms of student numbers. Anecdotal evidence suggests that workers from overseas are being used to address skills gaps in technical computing capabilities which are currently in short supply in Australia.

Higher education

The higher education market is one of the most important sources of new domestic talent to the ICT sector. The increase in the use of digital technology across the broader economy, as well as increasing specialisation within ICT-related industries, means that higher education will be a critical source of ICT skills supply in the future.

The broad IT field of education includes: computer science, information systems and other information technology.[9] Furthermore, anecdotal evidence gathered in consultations with the business community indicates that employers also hire ICT workers from other fields of education where skills are transferrable, such as engineering, physics or maths. In particular, growth areas within ICT are increasingly requiring strong mathematical skills to take advantage of big data, for example through artificial intelligence (for more details, see box below).

Artificial intelligence and machine learning

Artificial intelligence has been identified as a high growth and disruptive area of ICT, particularly the area of machine learning. Machine learning is a form of artificial intelligence where computers teach themselves, as opposed to being instructed in what to do (as is the case with traditional programming). This involves training machines to identify patterns and make predictions by crunching vast amounts of data, allowing machines to handle problems and issues which previously had to be solved by humans.

Machine learning and artificial intelligence, as evidenced in robotic cars and automated trading in financial services, will be crucial in future developments in the ICT and robotics sectors. This is the case not only for large businesses but also for smaller start-up companies. A recent article in the Financial Times described artificial intelligence as 'one of the hottest trends in start-up investing', with significant investor interest in this area.[10] For the entrepreneurs and their employees who are facilitating these frontier developments in artificial intelligence, strong coding abilities and exceptional mathematical skills are essential.

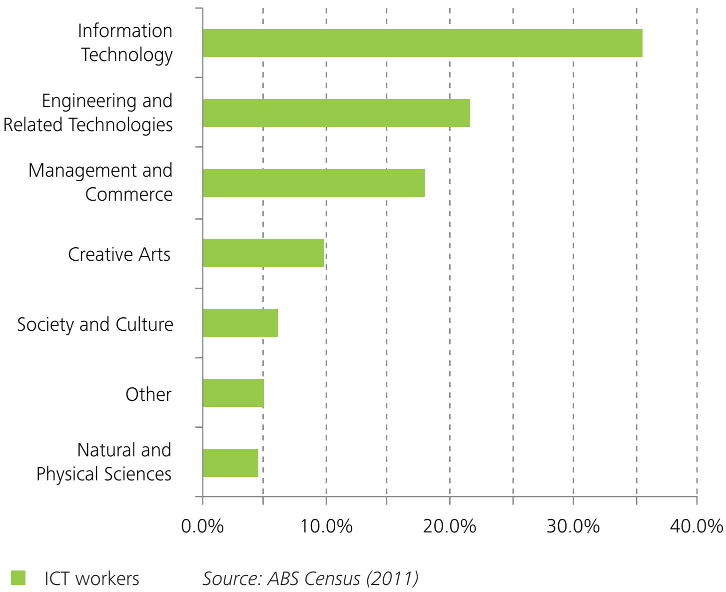
9. This is consistent with the ABS's Australian Standard Classification of Education.

10. For more details, see Financial Times (2015), Investor rush to artificial intelligence is real deal (http://www.ft.com/intl/cms/s/2/019b3702-92a2-11e4-a1fd-00144feabdc0.html).

Data on the fields of education studied by ICT workers in 2011 supports the idea that ICT workers can be sourced from a range of degrees. While the IT field of education is the largest feeder into ICT occupations, it only accounted for around 35% of ICT workers' field of education overall (Chart 2.2 and Table A.9). Engineering was a large source of ICT workers, while management and commerce was also a significant contributor. As a result, employers of ICT workers are by no means reliant on sourcing graduates solely from IT degrees.

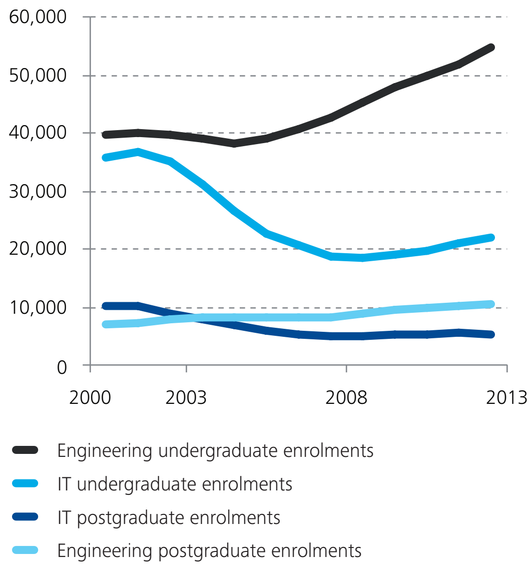
In contrast, engineering student enrolments have performed strongly over this period, with strong increases since the mid-2000s. However, while engineering degrees represent a significant source of ICT workers, this trend is likely related to the increase in employment opportunities in the resources construction sector presented by the mining boom (now waning), rather than an increase in enrolments in ICT-related engineering degrees such as computer or software engineering.[11]

Chart 2.2: ICT workers' field of education, 2011



Source: ABS Census (2011)

Chart 2.3: Domestic enrolments by field of education, 2001 to 2013



Source: Department of Education u-Cube (2015)

However, enrolments in IT degrees specifically have seen weak periods over recent years (Chart 2.3 and Table A.10). Domestic IT enrolments peaked in the early 2000s during the 'dot-com boom', but declined sharply over the 2000s despite a generally prosperous period for the broader economy. Domestic IT enrolments stabilised around the time of the global financial crisis in 2008 and have gradually increased since then, though they have remained well below previous highs.

As the lucrative employment opportunities afforded by the mining boom recede and the broader community increasingly grasps the prospects of the ICT sector, it can be expected that student interest will pick up again. Professor Roy Green, Dean of the University of Technology Sydney Business School, notes that there are already signs of this occurring as the digital economy grows in prominence across Australia (for more details, see the University of Technology Sydney box below).

11. A further breakdown of the engineering category into type of engineering degree is unavailable.

University of Technology Sydney

The University of Technology Sydney (UTS) is one of Australia's leading universities of technology. It offers a number of courses in information technology, computer science and engineering, with a focus on practice-based learning, industry engagement and user-centred research. Given the increasing importance of digital technology in business and innovation, joint courses in information technology and business are also offered at UTS. These courses are designed to equip graduates with the combined skills to apply an in-depth knowledge of information technology to business activities.

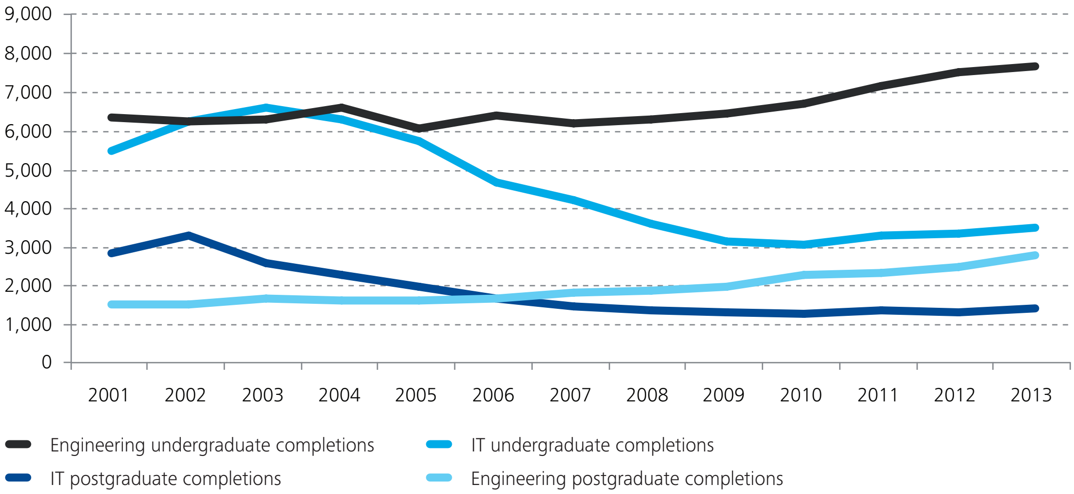
Professor Roy Green, Dean of the UTS Business School, believes that the future of the economy will increasingly be in 'design thinking and business analytics', skills which students develop through ICT-related degrees. 'These skills, as well as problem solving and critical thinking skills, need to be combined with specialised disciplinary thinking in order to foster innovation in the economy.' In light of this, UTS has created a new Digital Creative Hub Intersection to support the ecosystem of digital and creative start-ups in Sydney.

Professor Green thinks that the decline in domestic enrolments and completions in ICT-related degrees since the early 2000s is in part related to the mining boom in Australia over this period. 'During the mining boom, there was a decline in interest in technology courses in favour of mining-related courses. As the mining boom recedes, we could potentially see a swing back towards technology courses.' Consistent with this, 'UTS saw a 3% increase in enrolments in IT-related undergraduate courses in 2014, and based on 2015 offer-to-enrolled conversion figures, enrolments are still growing'.

Notwithstanding the recent pickup in IT enrolments, Professor Green acknowledges that the decline in technology graduates over the past decade has led to employers bringing in overseas workers on 457 visas in order to meet their technical skills needs. Further exacerbating this skills shortage is the fact that 'Silicon Valley companies are doing worldwide recruitment drives – so we are losing our best graduates to overseas when we don't have enough to begin with'.

Completions of IT degrees have followed a similar path to enrolments, peaking in the early 2000s before declining and stabilising over recent years (Chart 2.4 and Table A.11). The trend upwards in enrolments over the past couple of years indicates that completions should move modestly higher in coming years. In contrast, engineering completions are at record high levels, but may soon start to fade as employment opportunities driven by the mining boom recede.

Chart 2.4: Domestic completions by field of education, 2001 to 2013



Source: Department of Education u-Cube (2015)

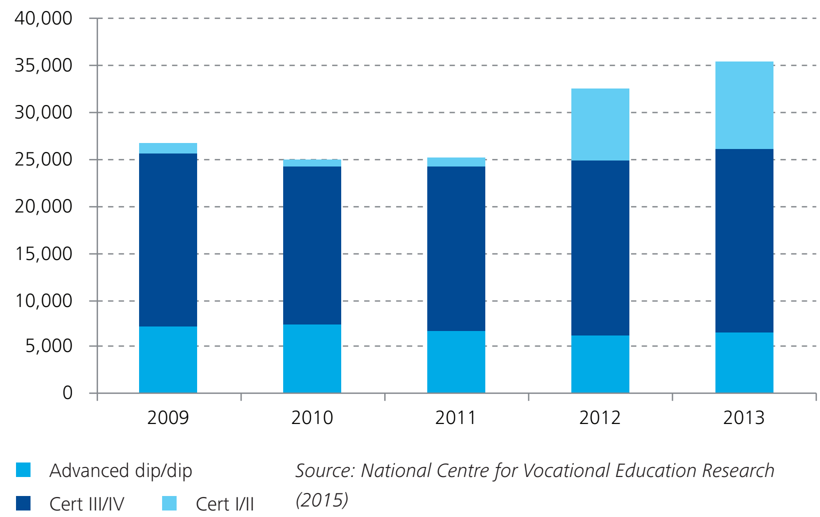
Overall, the low level of domestic ICT degree completions has resulted in a weak graduate pipeline of ICT workers. Some employers have also been disappointed by the quantity and quality of students graduating from domestic universities. While there are signs student interest is starting to turn around, the argument that the sector suffers from an 'image problem' which affects its ability to attract high quality students perhaps still has merit. In 2013, the Australian Workforce Planning Authority (AWPA) reported in its *ICT Workforce Study*: 'The ICT industry and profession has an image problem. Persistent and long-held negative perceptions of predominantly male ICT professionals engaged in desk-bound, repetitive, isolating jobs have implications for the pipeline of ICT skills.'

At a colloquial level, the ICT industry is consistently portrayed with this stereotype in popular culture (for example, in TV programs such as *The IT Crowd*), while other professions are gloried in terms of money and prestige in the entertainment space (such as law, finance and medicine). This could be contributing to the industry's image problem amongst younger generations in particular.

Vocational education and training

Vocational education and training (VET) relevant to the IT industry has picked up in the past couple of years with enrolments and completions increasing significantly from 2011. Certificates, particularly the introductory Certificate I level, have been the key driver of this increase in total enrolments (Chart 2.5 and Table A.12), and greater levels of such introductory training may provide some impetus for students to seek further (higher level) training at a later stage.[12]

Chart 2.5: VET enrolments in the IT field of education, 2009 to 2013



Source: National Centre for Vocational Education Research (2015)

Aside from the formal qualifications received through vocational and tertiary education, it should be noted that on the job training is also important for developing ICT skills in the workforce. For example, a representative from the Department of Immigration and Border Protection's ICT Division notes that such training is important for keeping workers' skills up to date given the rapidly changing nature of digital technology (for more details, see the Department of Immigration and Border Protection box below).

Australian Department of Immigration and Border Protection

The Department of Immigration and Border Protection (DIBP) is the Federal Government department responsible for managing migration, humanitarian and citizenship policy and programmes. DIBP works to keep Australia secure through border management and facilitates travellers crossing the border.

DIBP has significant digital technology needs and requirements, as ICT is a critical business enabler that supports all aspects of the Department's activities. DIBP currently employs an ICT workforce of around 1,600. The Department employs a broad set of ICT occupations, 'including business analysts, testers, infrastructure specialists, security analysts, network operations analysts, helpdesk workers and program management staff'. These employees work on projects that are both internal and external facing, and the pervasiveness of digital technology across the organisation highlights the importance of ICT within large Government departments.

However, despite the size of DIBP's ICT workforce, there are still a number of gaps in relation to the technical skills required within the organisation. Increasing the supply of qualified ICT workers is not just about increasing graduates from ICT-related degrees. 'It's also important for ICT workers to keep upskilling and regularly refreshing their skill set, including non-technical skills. Given the rapid pace of technological change, this includes on the job training in addition to formal qualifications in order to keep skills up to date. It's not just about the inflow of ICT Entry Level staff, apprentices, cadets and graduates, but also about managing the process of ICT change and staying innovative.'

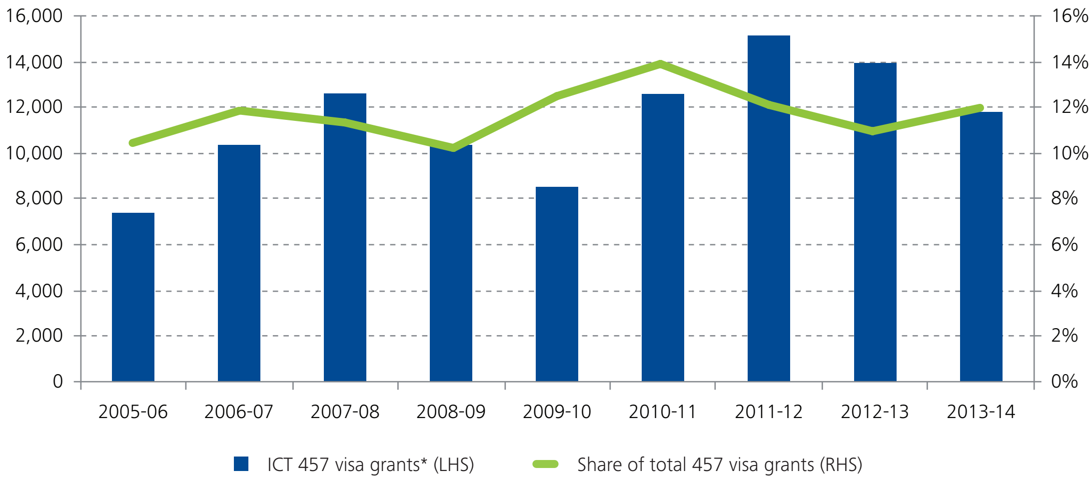
12. The large increase in Certificate I enrolments in 2012 are in large part due to classification issues, as non-AQF (Australian Qualifications Framework) qualifications fell sharply at the same time, indicating that those qualifications may now be classified as a Certificate I level.

Migration

Relative to many other professional occupations, ICT skills and workers are more readily transferrable between countries. For example, there is likely to be less country-specific knowledge required to perform an ICT role than, say, a position in law or finance which might involve more detailed knowledge of local regulation and government policy. This suggests that skilled migration is likely to be a more realistic option for filling ICT-related vacancies in Australia, compared with other professional roles.

A moderate share of temporary 457 visas (which allow skilled workers to work in Australia for a period of up to four years with approved Australian businesses) have been granted to ICT workers. Visa grants for temporary skilled migration of ICT workers have historically accounted for around 10–15% of total 457 visa grants (Chart 2.6, or Table A.7 for more details). In the 2013–14 financial year, almost 12,000 ICT workers were granted 457 visas, representing 12% of total visas granted.

Chart 2.6: Subclass 457 (temporary skilled work) visas in the ICT sector



** 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, Subclass 457 Visa Statistics (2015)

More than 10,000 457 visas per year have been granted to ICT workers over recent years. While temporary skilled migration of a little more than 10,000 workers per year is not a significant number in a workforce totalling around 600,000 ICT workers, anecdotal evidence indicates that 457 visas are being used to address skills gaps in key areas of technical computing capabilities within the ICT workforce. In particular, consultations with the business community suggest that there are shortages in skills such as programming and coding, computer science theory and computational thinking, which could potentially be associated with the weak graduate pipeline.

The view that there continues to be ongoing domestic shortages in technical ICT skills is supported by the fact that the occupation in which the most 457 visas are granted out of all ICT roles is software and applications programmers. In recent years, between one-third and one-half of all 457 visas granted to ICT workers have been to this particular occupation, suggesting that programming skills are in short supply amongst domestic workers. Deloitte's report *Australia's STEM workforce: a survey of employers* (2014) also found that these technical capabilities are valuable to Australian employers, with more than half of all employers of technology-qualified individuals rating programming skills as important or very important in an employee.[13]

13. For more details, see Deloitte (2014), Australia's STEM workforce: a survey of employers <http://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-economics-australia-stem-workforce-report-010515.pdf>.

Consistent with the data on 457 visa grants, software and applications programmers also recorded the highest visitor arrivals for employment purposes amongst all ICT occupations, with around 5,800 workers arriving in Australia in 2013–14 (Table 2.3, or Table A.8 for more details). Significantly, the occupation recorded only 600 residents departing for employment purposes, resulting in a net migration inflow of around 5,200 programmers.[14] This accords with the views of employers in the industry that technical skills are in short supply domestically. More broadly, across all ICT occupations there were around 21,000 arrivals and only 2,000 departures in 2013–14, indicating that Australia received a pronounced net 'brain gain' of ICT workers and skills over this period.

Table 2.3: Arrivals and departures of ICT workers, 2013–14

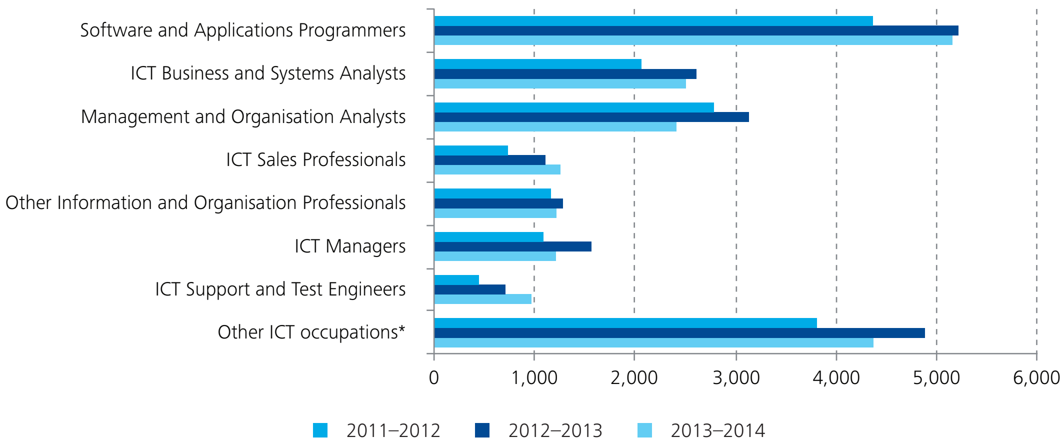
	Arrivals	Departures	Net migration
Software and Applications Programmers	5,797	645	5,152
ICT Business and Systems Analysts	2,630	127	2,503
Management and Organisation Analysts	3,180	771	2,409
ICT Sales Professionals	1,260	6	1,254
Other Information and Organisation Professionals	1,223	6	1,217
ICT Managers	1,335	123	1,212
ICT Support and Test Engineers	969	3	966
Other ICT occupations	4,687	321	4,366
Total ICT workers*	**21,081**	**2,002**	**19,079**

** 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 (2015)

This net 'brain gain' of ICT skills has been an ongoing trend, with net arrivals of ICT workers for employment purposes totalling between 16,000 and 21,000 in recent years. In particular, arrivals of software and applications programmers have been relatively high for a number of years (Chart 2.7). The consistently elevated number of arrivals of programmers reinforces the notion that employers are relying on workers from overseas to meet their needs in technical ICT skills and capabilities.

14. Note that these figures do not account for any potential double counting which could be associated with the same ICT worker arriving in Australia twice in one year.

Chart 2.7: Net migration of ICT workers, 2011–12 to 2013–14



**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 (2015)

Some employers of ICT workers have indicated that there could be an element of circularity related to employment of domestic workers in ICT occupations. Australian students are reluctant to study ICT-related degrees due to a perception that ICT jobs are going offshore or to temporary migrants. As a result, these jobs do go overseas or to foreign workers in Australia due to a weak pipeline of domestic graduates with technical capabilities.

Industry experts have observed that this is a concern in relation to ICT roles that are being commoditised and offshored (discussed above in Chapter 1), particularly for entry-level roles. While the offshoring of these positions allows Australian businesses to fulfil some of their ICT skills needs now, a reduction in the number of entry-level ICT workers employed in Australia now could potentially result in an insufficient talent pool for more advanced roles in the future. Increased offshoring of ICT roles means that there are fewer workers being trained domestically, which could lead to fewer employees progressing through ICT careers in Australia into management roles in future years.

Overall demand and supply balance

The overall Australian ICT labour market appears to be adequately supplied at present, noting the reliance on workers from overseas. However, the expected increase in future demand for ICT workers means that skills shortages – particularly in technical capabilities – could constrain future economic activity. This suggests that domestic completions of ICT-related tertiary degrees will need to rise from their currently subdued levels. Raising female participation in ICT occupations could also increase the future supply of ICT workers.

Amidst the domestic shortage in ICT skills, Australian employers have been turning to workers from overseas to meet their skills needs, particularly in technical capabilities. As a result of this, it appears that there are no acute worker shortages in the ICT sector at present. Information published by the Department of Employment supports the idea that the ICT labour market is adequately supplied at present. A 2014 listing of selected ICT-related occupations and the Department's shortage ratings for each role showed that the Department determined no skill shortages across all occupations listed (Table 2.4).

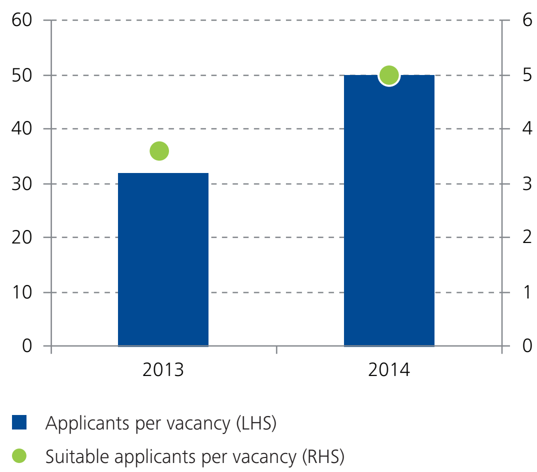
Furthermore, recent analysis conducted by the Department found that competition for vacancies in ICT employment increased over the year, with an average of 49.9 applicants per vacancy in 2014, up from 31.9 in 2013 (Chart 2.8). The number of suitable applicants also increased over this period, from 3.6 per vacancy in 2013 to 5.0 in 2014. The analysis also found that qualifications were not a key requirement for most ICT occupations. Rather, there was a significant focus placed on certifications in software packages and relevant experience.

Table 2.4: Selected ICT occupations and shortage ratings, 2014

Occupations	Title	Rating
2611–11	ICT Business Analyst	No shortage
2611–12	Systems Analyst	No shortage
2613–11 and 2613–12	Analyst and Development Programmer	No shortage
2613–13	Software Engineer	Recruitment difficult for software engineers with high level security clearance
2631–11	Computer Network and Systems Engineer	No shortage

Source: Department of Employment, Labour Market Research – Information and Telecommunications (ICT) Professions (2014)

Chart 2.8: Trends in applicants for ICT employment, 2013 to 2014



Source: Department of Employment, Labour Market Research – Information and Telecommunications (ICT) Professions (2014)

In summary, the supply of domestic graduates from ICT-related courses currently remains at low levels. This may reflect image problems related to the ICT profession, as well as the perception that hiring foreign ICT workers has resulted in a limited number of jobs for domestic graduates. However, there continues to be a healthy demand for ICT skills given the increasing role of digital technology in the Australian economy.

Employers have looked to workers from overseas and recruiting employees on 457 visas to meet their skills needs. This inflow of migrant ICT workers on 457 visas, along with support from the modest tertiary pipeline of ICT skills, has resulted in an adequately supplied ICT employment market for the present. That is, like many industries in the Australian economy, the supply of workers is currently sufficient to meet demand for workers. This is also reflected in the fact that wage pressures in many industries with a large share of ICT workers – including the Information, Media and Telecommunications industry and the Professional, Scientific and Technical Services industry – are no higher than in the broader economy, where wage growth has been relatively low by historical standards (running at 2.5% in 2014).

This raises the question of whether an employment equilibrium where a large share of the demand for ICT workers is met by a supply of imported ICT skills is ultimately beneficial for the Australian economy. On the one hand, it could be argued that if Australia does not have a comparative advantage in ICT workers (particularly in technical competencies), it is logical to import skills using migrant workers on 457 visas.

On the other hand, it is clear that demand for ICT workers in Australia is forecast to increase in future years as the digital economy continues to grow, with almost 100,000 additional ICT workers required by 2020. Skills demand is also expected to steadily increase.

This could cause further skills shortages, and a reliance on foreign ICT skills may leave Australia vulnerable to these shortages if the supply of foreign ICT workers is unable to be sustained – for example, due to increasing competition for these workers as noted in AWPA's 2013 *ICT Workforce Study*: 'As Australia competes with emerging economies for this skilled labour, and as the demand for ICT workers across a range of professional, technical and trade occupations increases in coming years, a substantial increase in the domestic supply of ICT specialists will be required.'

Indeed, Australian employers are already showing signs of apprehension about potential skills shortages in the future, particularly in technical capabilities given the forecast growth in demand for higher educational qualifications. Although skills needs are currently being met, the modest tertiary pipeline of skills due to the subdued rate of enrolments in ICT-related degrees and the reliance on workers from overseas to meet ICT skills needs, is of concern. This suggests that it will be necessary to increase the domestic uptake of ICT-related degrees going forward.

Consultations with the business community reinforce the fact that industry is particularly concerned about potential skills shortages in advanced technical capabilities, rather than in general ICT skills. For example, Sally-Ann Williams, Engineering Community and Outreach Program Manager at the Google Australia office, identifies programming skills, computer science theory and computational thinking as key areas where there are domestic skills gaps in Australia (for more details, see the Google Australia box below).

Google Australia

Google's Australian office in Sydney is one of the company's largest global engineering centres. Over 1,000 workers are employed in the Australian office, with a little over half of these comprising of engineers who work on product development and infrastructure.

Sally-Ann Williams, Engineering Community and Outreach Program Manager at Google Australia, says that engineers recruited to Google's Australian office are required to have a broad set of technical skills. She adds: 'Google is and always will be an engineering company. We hire people who are ready to tackle some of technology's greatest challenges and who want to make a positive impact on millions of people.'

She notes Australia's skills shortage in technical occupations such as software engineers, programmers and computer scientists. 'The skills gap in Australia is at the higher levels of technical capabilities such as core computer science and programming skills, rather than in the broader category of workers who are competent in the use of technology', she notes.

Google Australia supports the new Digital Technologies curriculum (discussed in further detail below in Chapter 3) as a means for addressing the domestic shortage in technical capabilities in the long-term future. In particular, Sally-Ann believes that 'engaging students at the primary school level will encourage more students, particularly females, to develop technical capabilities and pursue further study in computer science'.

Another option for increasing the supply of ICT workers in the future is raising female participation rates in ICT occupations. For example, bringing the number of women employed in the ICT workforce up to the number of men currently working in ICT occupations would result in around 270,000 additional ICT workers. This could be another way of strengthening the domestic pipeline of ICT skills, but would require addressing the issues which are currently discouraging women from working in ICT occupations (discussed in Chapter 1).

Another question to ask is whether the lack of an ICT skills gap at present in Australia is a problem. As discussed earlier, Australia ranks around the middle of the pack compared to other developed countries with respect to the size of its ICT workforce, and also has relatively low levels of ICT research and development by international standards. If the ICT workforce is adequately supplied because businesses have stopped demanding ICT workers due to a lack of domestic skills, this could inhibit future innovation and productivity growth in the Australian economy.

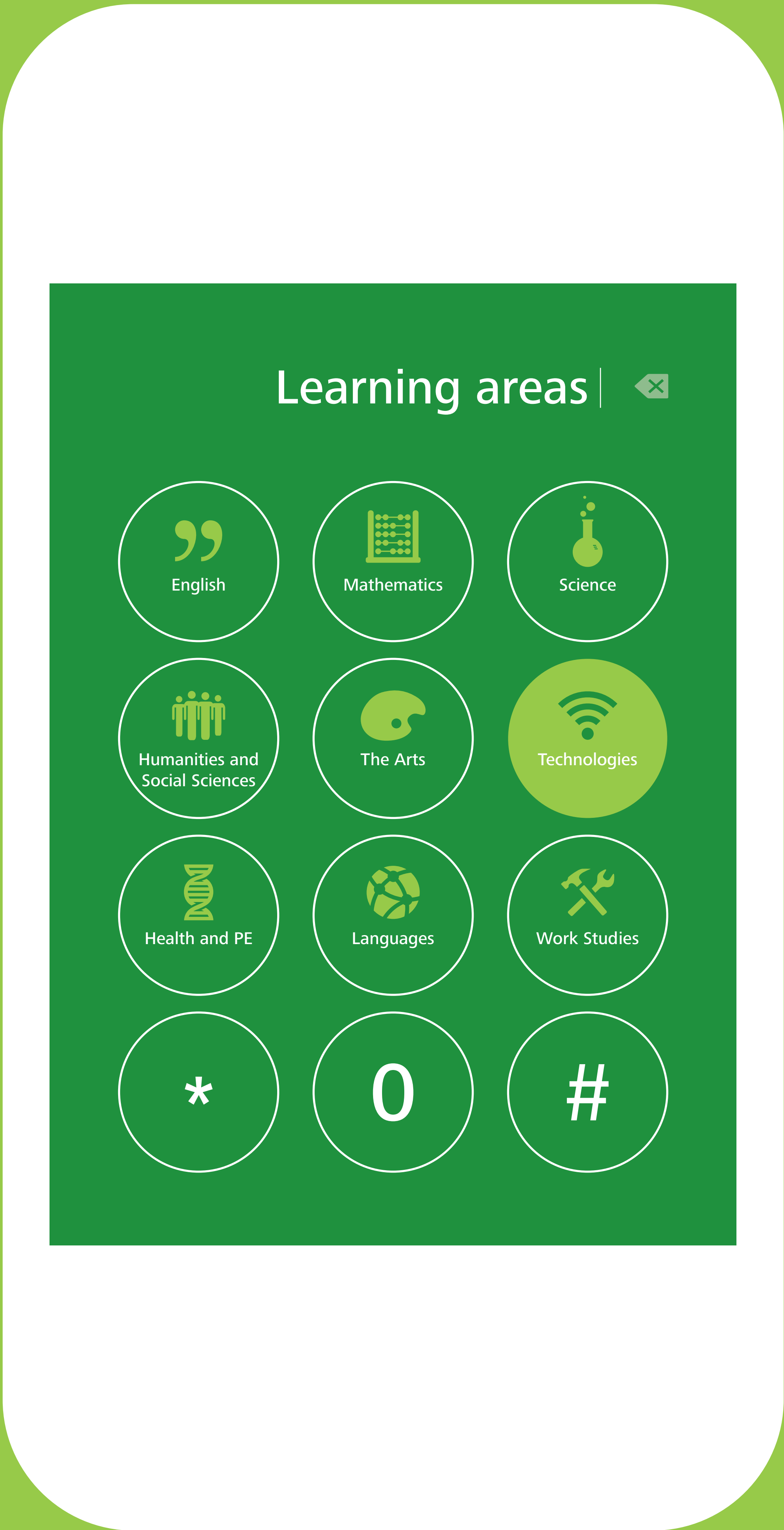
3

ICT education in schools

This chapter discusses the benefits of incorporating ICT into school education, and assesses the digital literacy of Australian school students. The chapter also examines ICT education in the school curriculum and how well-equipped Australian teachers and schools are for teaching ICT to students, as well as providing some international examples of ICT education.

▶ *ICT learning areas in the Australian Curriculum, foundation to year 10*

Subjects


Learning areas
English
Mathematics
Science
Humanities and Social Sciences
The Arts
Technologies
Health and PE
Languages
Work Studies
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The need for ICT education in schools

There are significant benefits associated with the inclusion of ICT in school education. Aside from increasing student engagement, teaching computer science or programming in schools will enable students to build their computing skills from a young age. This is an important step in increasing the technical capabilities of Australia's future workforce.

As demand for workers with ICT skills is expected to increase over the coming years, ICT education in Australian schools will be crucial, both for building the foundation ICT skills required of the future Australian workforce, and for increasing students' interest in studying ICT to ensure that the supply of ICT workers can keep pace with the rising demand.

There are two main ways that ICT can enter the school curriculum: through a specific ICT component in the syllabus, or by integrating ICT use into other areas of the curriculum. The first method might take the form of computer science or programming classes. The latter could involve the use of ICT for collaborative purposes, adaptive technologies for personalising learning or online-based teaching methods.

Studies have found significant wider benefits associated with developing foundational ICT skills through the general use of technology in school. In addition to increasing digital literacy more broadly, teaching and learning using ICT can increase student engagement by facilitating greater collaboration, independence and accessibility. There is also a positive association between school children's ICT use and their academic achievement across other areas such as English, mathematics and science.[15]

However, given the increasingly digital nature of the economy, it is not sufficient for Australian school students to just be comfortable using technology. Students also need to develop their technical computing skills from a young age, so that they can design, build and implement digital solutions and applications when they enter the workforce in the future. As discussed above, digital disruption is changing the nature of many occupations in the Australian workforce, and strong technical capabilities are increasingly being required in many roles that had not previously been associated with traditional ICT positions. The inclusion of computer science or programming classes in the school curriculum is an important step in ensuring that schools educate their students in these skills.

This can also help to narrow gaps in ICT skills between different groups of students. The OECD has recently noted that while ICT proficiency has generally increased, a 'digital divide' is emerging whereby some students are less likely to be users and producers of digital technology – in particular, girls and children from disadvantaged backgrounds.[16] Including computer science subjects in the school curriculum can help to narrow this divide by providing these groups with the opportunity to develop skills in new technologies.

15. For example, see Balanskat, Balmire and Kefala (2006), The ICT Impact Report: A review of studies of ICT impact on schools in Europe <http://www.pedz.uni-mannheim.de/daten/edz-b/gdbk/06/ict_impact_report.pdf> and Oakley, Pegrum, Faulkner and Striepe (2012) Exploring the Pedagogical Applications of Mobile Technologies for Teaching Literacy <http://www.education.uwa.edu.au/__data/assets/pdf_file/0003/2195652/AISWA-Report-FINAL-Final-101012-2.pdf>.

16. For more details, see OECD (2014), Trends Shaping Education 2015: Spotlight 5 <http://www.oecd.org/edu/ceri/Spotlight%205-%20Infinite%20Connections.pdf>.

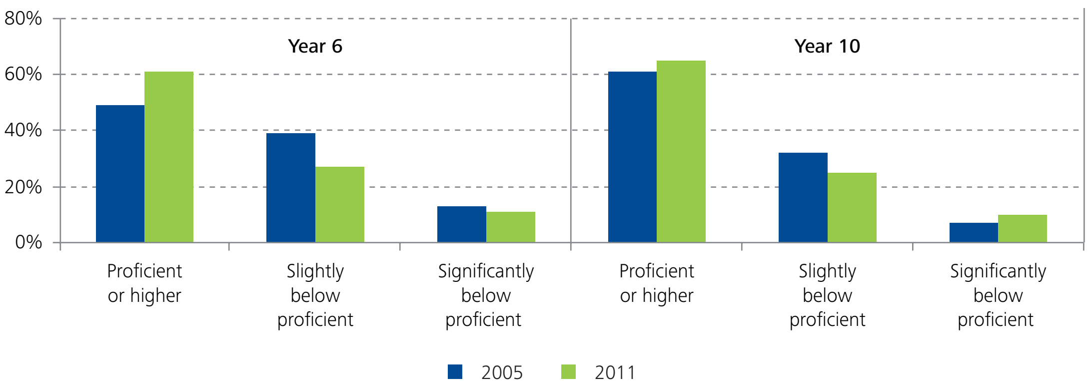
Australian students' ICT literacy

While a majority of Australian school students are of a proficient standard in ICT literacy, around 10% achieve a standard significantly below proficient. This has been relatively unchanged since 2005, suggesting that there are areas that could be improved in ICT school education in order to avoid the entrenchment of a 'digital divide'.

As part of the National Assessment Program (NAP), a sample of Australian students in Years 6 and 10 are tested on their ICT literacy every three years. In 2011, around 11,000 students from both government and non-government schools were assessed on their ability to use ICT to access and evaluate information, develop new understandings, and communicate with others.[17]

Based on the proficiency levels identified in the NAP, a little more than 60% of Year 6 and 10 students reached or exceeded the proficient standard for ICT literacy in 2011 (Chart 3.1). The share of students proficient in ICT has risen since 2005, with the increase particularly pronounced for Year 6 students. While this is a welcome development, between 2005 and 2011, the share of students whose ICT literacy was significantly below proficient has been relatively unchanged at around 10% for both Years 6 and 10, which is a concern.

Chart 3.1: Australian students' ICT literacy proficiency standards, 2005 and 2011



Source: Australian Curriculum, Assessment and Reporting Authority (2012)

In particular, the NAP results found that students' ICT literacy varied considerably across a number of demographics. Students attending schools in remote areas, and students with parents of lower occupational and educational status, were significantly more likely to have lower ICT literacy proficiency. This may be related to the frequency of computer use by students from different socioeconomic backgrounds. While almost every Australian student had access to a computer at home, the share of students who were frequent computer users at home was lower for students living in remote areas and those whose parents were unemployed or in unskilled occupations.

ICT education in schools is one means of increasing access to ICT for students from lower socioeconomic backgrounds. However, across many of these relatively disadvantaged demographics student computer use is lower at school as well as at home. An improvement in ICT education across schools located in disadvantaged areas, for example through increased computer science classes, could assist these students with developing their ICT skills and technical capabilities.

17. The 2014 ICT literacy assessment was completed in November 2014. A public report on the results of this assessment will be released later in 2015.

ICT education in Australian schools

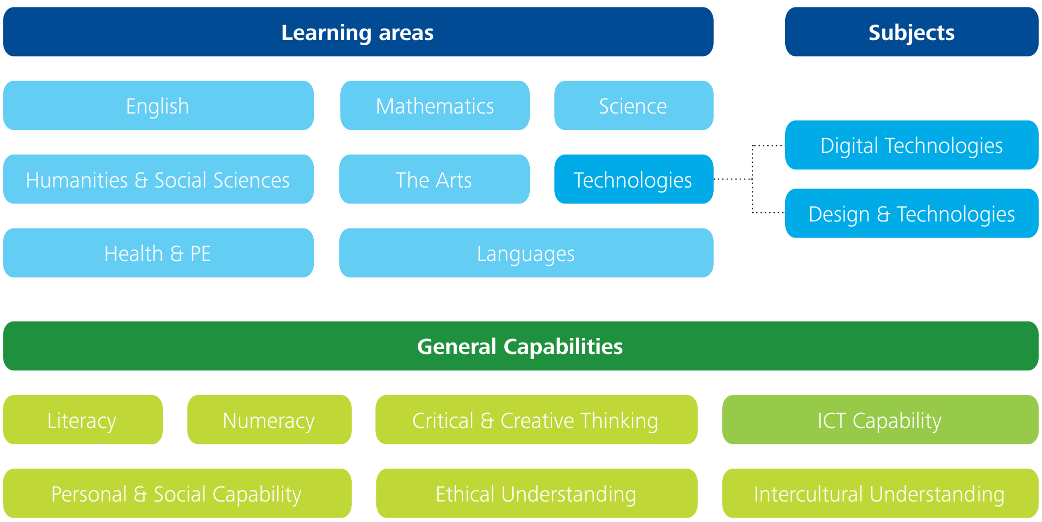
The Australian Curriculum includes a Digital Technologies subject that is aimed at increasing the technical ICT capabilities of Australian students. It is currently up to state and territory curriculum and school authorities to decide when and how this curriculum should be implemented in schools. This subject will be particularly important for developing the computing skills of younger primary school students.

Given the rapidly changing nature of technology and the fact that widespread technology use is relatively new in some classrooms, states and territories may need to invest in training programs to upskill their teachers. Governments, industry associations and education institutions have introduced a number of professional development initiatives to ensure that teachers are equipped with the necessary skills.

ICT in the Australian Curriculum

Australia's national curriculum includes a Technologies learning area comprising of two subjects: Digital Technologies, and Design and Technologies. The Digital Technologies subject focuses on teaching students to use computational thinking and information systems to define, design and implement digital solutions. The Design and Technologies subject teaches students to use design thinking and technologies to produce designed solutions for problems and opportunities. The inclusion of these subjects in the curriculum is part of addressing the broader challenge of developing STEM capabilities in Australia's workforce. In addition to the Technologies learning area, ICT has also been nominated as one of seven general capabilities that should be developed across all learning areas of the Australian Curriculum (Figure 3.1).

Figure 3.1: ICT learning areas and general capabilities in the Australian Curriculum, foundation to year 10



Source: Australian Curriculum, Assessment and Reporting Authority (2015)

It is the Digital Technologies subject in particular that is aimed at increasing the technical capabilities of Australian students. Given the expected increase in demand for ICT workers over the next few years, this will be a significant step towards building the computing skills of Australia's future workforce. However, it is likely to be many years between the introduction of a Digital Technologies curriculum an increase in the quantity and quality of ICT skills in the workforce. This means that it is important that the implementation of the curriculum occurs as quickly as possible.

While the Technologies curriculum has been made available for state and territory use, it is still awaiting final endorsement. As such, the curriculum is currently not mandatory in Australian schools and it is up to state and territory curriculum and school authorities to decide on when and how they will implement it in schools how they will implement it in schools. Consultation with the Australian Curriculum, Assessment and Reporting Authority (ACARA) suggests that different states and territories are at different stages of the implementation process, with a number of states already developing classroom materials, professional learning workshops and curriculum trials for the Digital Technologies curriculum (for more details, see the ACARA box below).

Australian Curriculum, Assessment and Reporting Authority

The Australian Curriculum, Assessment and Reporting Authority (ACARA) is the independent statutory authority seeking to improve the learning of all young Australians through world-class school curriculum, assessment and reporting.

'The Australian Curriculum strives to meet the learning needs of students, employers and the community in the 21st century.' says Robert Randall, Chief Executive Officer of ACARA. 'Importantly, the national curriculum sets expectations for all young Australians wherever they go to school. Development of Australian Curriculum for Foundation to Year 10 in eight learning areas represents is a significant milestone for school education in Australia.'

As one element of the Australian Curriculum, the Digital Technologies curriculum was developed through a rigorous process of writing, national consultation and review. One of the key ideas in the Digital Technologies curriculum is the development and use of computational thinking, which is a way of thinking about information systems and how to create solutions.

While the curriculum is awaiting final endorsement by the Education Council, it is available now for use. Different states and territories are at various stages in the implementation process, including writing classroom materials, providing professional learning workshops for teachers, or trialling the new curriculum in schools. Other states and territories are waiting for its final endorsement before announcing their approach to implementation.

For example, in Victoria, the Department of Education and the Victorian Curriculum and Assessment Authority (VCAA) have been working on developing and implementing the new curriculum, with the current aim that schools will be teaching the Digital Technologies curriculum to students by the end of 2017 (for more details, see the Victorian Department of Education box below). While the new curriculum is being developed and implemented, students continue to be taught the existing curriculum which includes an interdisciplinary domain on developing ICT literacy – similar to the ICT general capability discussed above – but has no focus on technical capabilities or computational thinking.

Victorian Department of Education

In Victoria, the Victorian Curriculum and Assessment Authority (VCAA) – an independent authority under the auspices of the Department of Education – is responsible for the Early Years to senior secondary curriculum, including the Digital Technologies curriculum from Foundation to Year 10, which is expected to be based on the Australian Curriculum. The Department is responsible for supporting schools in implementing the new curriculum. While the Technologies curriculum is still awaiting official endorsement, Victorian authorities have already begun working on professional learning programs to support the implementation of the new Digital Technologies curriculum given the importance of developing these skills in school students.

Paula Christophersen, the Curriculum Manager of Digital Technologies at VCAA, states that in Victoria the Digital Technologies curriculum has been developed to 'teach students to be confident developers of digital solutions'. She emphasises that the focus is not solely on coding and using digital devices, but also on 'building skills in algorithmic thinking and logic, creating digital solutions through the use of computational thinking'.

On the framework for the ICT general capability, Paula says that 'the Australian Curriculum, as it will be implemented in Victoria, includes content to develop students' digital literacy across all other learning areas'. For example, 'Geography uses geographic information systems and mapping technology; Mathematics includes network analysis, graphing and data visualisation; while the expectation in humanities subjects such as History is that students will access and interpret data and information from digital sources and web-based documents.'

While the implementation of the curriculum in some other states is more centrally determined, schools in Victoria are relatively autonomous and can make their own decisions regarding how they implement the Digital Technologies curriculum, supported by Department of Education resources.

Penelope Rowe, Senior Project Officer in the Digital Learning Branch of the Department, states that the Department offers a suite of tools to help teachers develop effective teaching and learning practices using digital technology. 'These include an online repository of resources with educational materials for teachers, and hosting workshops such as ICT planning workshops to help schools understand the digital tools they have and how to use them.' More specifically in relation to the Digital Technologies curriculum, the Department (in partnership with other key stakeholders such as the Federal Department of Education and other states) is also developing an online tool with information on terminology, assessment, case studies and lesson plans for the new curriculum.

These resources are aimed at addressing some of the barriers that will need to be overcome in implementing the new curriculum. In particular, Penelope says a key challenge will be 'ensuring that teachers develop a holistic approach towards the curriculum and an understanding of how individual content descriptors sit together, as well as unpacking the language used in the curriculum'. She believes that this understanding will allow teachers to interpret the curriculum in an interesting way to students, enabling them to develop innovative methods of teaching the new Technologies subjects.

In contrast, in NSW the Board of Studies, Teaching and Educational Standards (BOSTES) is awaiting the final endorsement of the Technologies curriculum before it is implemented in the syllabus. However, there are already opportunities for students to develop technical capabilities in using and producing ICT within the current NSW curriculum, particularly throughout secondary school. Peter Thompson, Inspector of Technology Education at the BOSTES, states that this includes cross-disciplinary ICT applications, a mandatory Technology syllabus in Years 7 and 8, and technology-related electives in Years 9 to 12 (for more details, see the NSW BOSTES box below).

NSW Board of Studies, Teaching and Educational Standards

In NSW, the Board of Studies, Teaching and Educational Standards (BOSTES) is the government authority that manages the school curriculum, including a range of teaching, assessment, registration and policy functions.

The Australian Technologies curriculum is awaiting final endorsement by Ministers. When it is endorsed, NSW will plan a timeline for revisions to the relevant content in NSW syllabuses. It is important to note that there are already many opportunities for students to study, use and produce digital technology in the current NSW curriculum.

Peter Thompson, BOSTES Inspector, Technology Education, states that 'content from the Australian curriculum English, Mathematics, Science and History subjects has already been incorporated into NSW syllabuses for Kindergarten to Year 10. There has been an increase in explicit listings of ICT use within the new syllabuses of these subjects – in English for example, there has been a 400% increase in ICT usage in the syllabus'. This includes students building blogs and wikis, creating apps, and using software to create and edit films.

Aside from this cross-disciplinary engagement with digital technology, the NSW curriculum has a Technology (Mandatory) syllabus for Years 7 and 8. The course must be studied for at least 200 hours and teaches students an understanding of design processes and the technologies that can be used to produce innovative solutions to identified needs. Peter notes that this could include 'using software to develop portfolios, designing coded programs using Scratch, or working with other game making software'. The use of more fundamental ICTs such as Office applications, digital photography and ePortfolio production is common place.

In addition, the NSW curriculum has a number of technological subjects that can be studied by students in Years 9 to 12.

ICT courses for Years 9 and 10:

- Information and Software Technology elective which teaches students core technical skills such as systems design, computing, building networks and programming
- Coding can also occur within other syllabuses in the Industrial and Design and Technology learning area
- Photography and Digital Media syllabus as part of the Arts learning area

ICT courses for Years 11 and 12:

- Information Processes and Technology (IPT)
- Software Design and Development (SDD)
- VET Information and Digital Technologies (IDT) framework course

Peter observes that without implementing the Digital Technologies component of the Australian Curriculum, the current NSW syllabuses contain substantial digital technology-related content.

NSW Board of Studies, Teaching and Educational Standards... cont'd

A common national and global issue is that student interest in these subjects has been declining over recent decades. This is consistent with the NSW experience where 'in 2000 over 17,000 students were studying Computing Studies [the computing subject prior to the separation into IPT and SDD in 2000]. Now, the combined total of students studying IPT, SDD and the VET IDT course has reduced to around 6,000 students.' However, in NSW there has been an increase in students undertaking major ICT specific projects in a range of other HSC subjects such as English, Visual Arts, Design and Technology and Industrial Technology-Multimedia, Photography Video & Digital Imaging and Computing Applications.

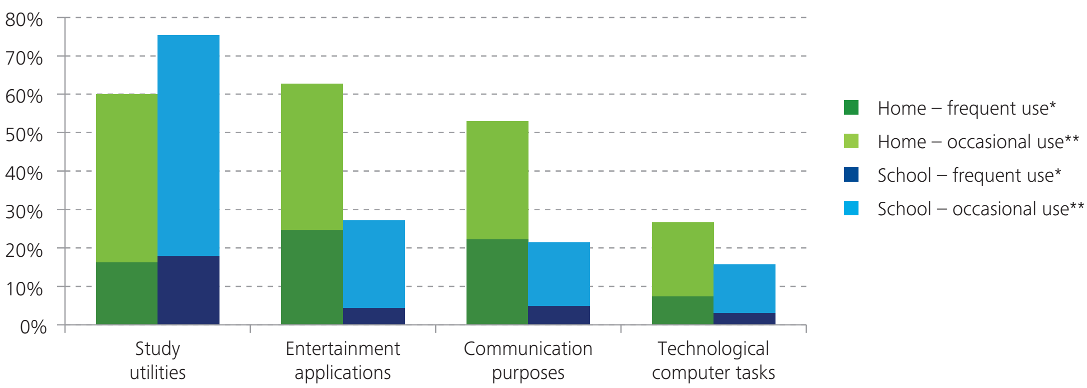
In order to address the general trend of decline, Peter suggests that 'world-wide, we need to ramp up students' and society's understanding of our technological needs – for example, more information on potential career paths and future opportunities in digital technology could be publicised to both students and parents'.

Additionally, some teachers are developing their skills and confidence in teaching and learning using information and communication technology, advanced manufacturing technology and control technology. Professional associations such as the ICT Educators of NSW (ICTE NSW) and the Institute of Industrial Arts Technology Education (IIATE) run a range of workshops to assist NSW teachers in developing their technical skills.

Industry consultations suggest that increasing students' interest in studying ICT at school is critical. This could involve the provision of more information on potential ICT career paths and future opportunities in digital technology to both students and parents, in order to increase society's understanding of future technological needs. Additionally, a key focus of the Digital Technologies curriculum is mandating the teaching of technical computer skills to students in primary school. Teaching students coding, algorithmic thinking and creating digital solutions from an early age is likely to increase their interest in technology-related subjects in the later years of schooling.

This is particularly important because relatively few students are currently learning these technical skills in their earlier years. The NAP results on Year 6 students' uses of computer applications show that ICT use for technological tasks such as writing macros, constructing websites and uploading user-created content is relatively low compared to ICT use for study, entertainment and communication (Chart 3.2).

Chart 3.2: Australian Year 6 students' regular ICT use by task, 2011



**Used almost everyday or more*

***Used between a few times a week and once a month*

Source: Australian Curriculum, Assessment and Reporting Authority (2012)

Equipping teachers and schools to teach ICT

Including digital technology and computing science in school curricula is one component of ensuring that Australian school students are educated in the technical ICT capabilities that will be required in the future workforce. Australian teachers and schools must also be sufficiently equipped with the skills and equipment required to educate students in the relevant subjects. Given the rapidly changing nature of technology and the fact that widespread technology use is relatively new in some classrooms, states and territories may need to invest in training programs to upskill their teachers.

A 2006 survey of around 1,500 teachers in Western Australia found that while 95% of teachers had access to a basic suite of ICT applications, only 18% regularly used ICT for teaching and learning.[18] Furthermore, 74% of all teachers viewed more or better access to computers as a factor that could increase ICT use in the classroom.

These figures are likely to have changed over subsequent years, owing to the rapid pace of technological growth. Broader trends such as the rising general digital literacy of the Australian population, and the increasing incidence of bring-your-own devices to schools, are having a positive effect. Governments have also invested more in developing teachers' ICT skills and supplying classrooms with the necessary equipment as ICT has become increasingly important to the Australian economy and society.

Research conducted by the U.S. Department of Education in 2011 on the international application of ICT in education highlights a number of government policies and programs in Australia that have supported increased ICT use in schools.[19] These include:

- The Digital Education Revolution, a large-scale ICT infrastructure project to increase hardware access and improve broadband connectivity in schools, and the Building the Education Revolution, which also funded the modernisation of school facilities
- The inclusion of ICT in the Australian Curriculum, providing a comprehensive nationwide plan for integrating ICT into primary and secondary education, as well as a program to monitor its implementation
- The National Assessment Program in ICT literacy, which can be used to evaluate ICT use and proficiency levels in Australian students
- The ICT Innovation Fund, supporting professional development and teacher education courses in ICT use by funding programs such as the Teaching Teachers for the Future project.

These programs have seen solid results. For example, the Digital Education Revolution saw more than 900,000 computers supplied to Australian schools, with funding also provided to cover installation and supporting infrastructure such as wireless networking in classrooms. The Teaching Teachers for the Future project resulted in measurable growth in teaching students' confidence in using ICT as a teacher and in facilitating student use of technology as future teachers.

18. For more details, see WA Department of Education and Training (2006), Teacher ICT Skills <http://www.det.wa.edu.au/accountability/detcms/education/evaluation-and-accountability/binary-files/evaluation-reports/teacher-ict-skills-2006.en?cat-id=13027342>.

19. For more details, see U.S. Department of Education: Office of Educational Technology (2011), International Experiences with Technology in Education: Final Report <https://oerknowledgecloud.org/sites/oerknowledgecloud.org/files/iete-full-report.pdf>.

More recently, the national Digital Careers program was launched in 2013, and provides a coordinated national approach towards addressing ICT skills development in Australia. Digital Careers is delivered by National ICT Australia (NICTA) with a consortium of industry associations, state governments, research organisations and education providers, and the program includes a range of ICT-related activities and events aimed at growing the number and diversity of tertiary students preparing for a career in ICT. In addition, Digital Careers supports school teachers in their delivery of ICT-related activities by providing resources, advice and access to a comprehensive network of activities for students.

In relation to the Australian Curriculum more specifically, the University of Adelaide's Computer Science Education Research Group has developed a number of massive open online courses (MOOCs) to assist teachers in addressing the Digital Technologies subject within the Technologies learning area. Created with the support of Digital Careers and Google, these MOOCs introduce teachers to concepts and activities that will help to teach computer science and computational thinking to school students.

State governments are providing further teacher support as the Digital Technologies curriculum is developed and implemented. For example, the Victorian Department of Education is working with a range of other key stakeholders in order to develop an online tool with information for teachers on terminology, assessment, case studies and lesson plans on the new Digital Technologies curriculum. Industry and professional associations – such as ICTE NSW and IIATE in NSW, are also working with teachers to ensure that they are equipped with the necessary skills to teach technology-related subjects more broadly.

These initiatives all recognise the need to educate and prepare teachers to be able to deliver technology-related content in the school curriculum. Teachers across primary and secondary school must be equipped with the skills required to effectively educate students on the necessary technical computing capabilities. It is important that school teachers are supported as the Digital Technologies curriculum is developed and implemented, particularly across the younger year levels where ICT education will be critical in building the computing skills in Australia's future workforce.

International experiences in ICT education

In recent years, there has been an increasing global push towards introducing computer science and technical computational skills into school curricula. Israel was an early adopter of computer science in its high school syllabus, while more recently England has introduced coding classes into primary school. The United States also intends to develop computer science education in American schools. The implementation of the Digital Technologies curriculum will ensure that Australia does not fall behind other countries in ICT education.

There has been an increasing focus on ICT education in a number of countries around the world across all levels of education, from kindergarten and primary school up to high school students. In particular, there has been a global push towards school education in computer science and technical computational skills such as programming which are currently in short supply not just in Australia, but across numerous other countries.

Israel

Israel was one of the first countries to focus on computer science teaching in high school classrooms. The Israeli curriculum was launched in 1995, with more detailed curricula and course syllabi published in subsequent years. The high school program in Israel 'emphasises the foundations of algorithmics, and teaches programming as a way to get the computer to carry out an algorithm'.[20]

Machshava, the Israeli National Centre for Computer Science Teachers, has ensured computer science learning is embedded within schools. Machshava was established by Israel's Ministry of Education in 2000, and now hosts conferences and courses related to computer science education as well as publishing papers and learning materials relevant to the Israeli curriculum. Furthermore, Machshava supports the growth of the computer science education community across Israel by holding professional development courses for leading computer science teachers, who then go on to run workshops for their colleagues around the country.

England

In contrast, England has only recently introduced computer science into its school curriculum. A new computing curriculum for primary and secondary school studentswas launched in September 2014. The new curriculum focuses on coding and programming rather than broader ICT capabilities, with the (then) Education Secretary Michael Gove noting that it 'teaches students computer science, information technology and digital literacy; teaching them how to code and create their own programs; not just how to work a computer, but how a computer works and how to make it work for you.'[21]

Under the new system, it is up to schools to decide on whether they wish to introduce separate computing lessons or incorporate the learning requirements into other subjects. The government has funded the British Computer Society to develop training programs and learning materials for teachers who are new to teaching computing. Private companies have also contributed, with Google and Microsoft partnering with Code Club and Computing at School to run training sessions on computing skills for both primary and secondary school teachers.

20. See Gal-Ezer and Harel (1999), Curriculum and Course Syllabi for a High School Program in Computer Science <http://www.openu.ac.il/Personal_sites/download/galezer/curr_and_syll.pdf> and Gal-Ezer, Beeri, Harel and Yehudai (1995), A High School Program in Computer Science <http://www.openu.ac.il/Personal_sites/download/galezer/high-school-program.pdf>.

21. For more details, see UK Government (2014), Michael Gove speaks about computing and education technology <https://www.gov.uk/government/speeches/michael-gove-speaks-about-computing-and-education-technology>.

United States

The United States is another country where private companies, educational groups and industry organisations are working together to educate school teachers on incorporating computer science into their classes. In 2014, around $20 million was pledged by a group of companies (including Google, Microsoft and Salesforce) and philanthropists to train 25,000 teachers to teach computer science by the 2016 school year. Code.org will use the funds to host workshops teaching computer science modules to primary, middle and high school teachers.

A key challenge associated with introducing computer science into schools across the United States is the fragmented nature of the education system. Public school systems are locally administrated and their structure varies by state and region, with more than 14,000 public school districts across the country. Notwithstanding these difficulties, in December 2014 the White House announced that a number of school districts – including the seven largest districts in the country – have committed to offering introductory computer science courses at the high or middle school level, reaching more than four million students. Other education non-profit organisations such as the National Science Foundation, the College Board and Teach For America have also announced initiatives to support computer science education in the United States.[22]

Implications for Australia

The Digital Technologies curriculum will ensure that Australia is relatively well-placed globally in the ICT education space. However, this curriculum is still awaiting final endorsement and, as shown in the examples illustrated above, other countries such as Israel and England are already ahead of Australia in implementing computer science into primary and secondary school curricula. Given the delay between introducing the curriculum and seeing increasing ICT skills among workers, Australian states and territories need to work towards developing and implementing the Digital Technologies curriculum, to ensure that Australia does not fall behind other countries in ICT education.

Australia can draw from the experiences in other countries in relation to the training and support provided to teachers on ICT education. For example, in England and the United States, the technology industry has taken a prominent role in teacher training, with companies such as Google and Microsoft funding and hosting training sessions and workshops for school teachers. Such programs could also be developed in Australia. A national centre for educating teachers on how to teach computer science and other technical skills, such as the model adopted in Israel, could be another method for teachers' professional development.

22. For more details, see White House (2014), Fact Sheet: New Commitments to Support Computer Science Education <https://www.whitehouse.gov/the-press-office/2014/12/08/fact-sheet-new-commitments-support-computer-science-education>.

Directions and barriers for ICT education

Given the increasing prominence of digital technology in the Australian economy, it is important that Australia further develops ICT education in the school system. This includes continuing to implement the Digital Technologies curriculum, as well as ensuring that teachers receive the appropriate training in teaching and learning using technology.

It is important that Australia further develops ICT education in its school system. In particular, the Digital Technologies curriculum will ensure that students are taught computer science, computational thinking skills, and how to design and build digital solutions from the younger years of their schooling. This will be essential in ensuring that Australia's future workforce is equipped with the ICT skills required to fuel innovation and productivity growth in a constantly changing technological environment.

However, the Technologies component of the Australian curriculum is currently awaiting final endorsement. Governments must ensure that this curriculum continues to be developed and implemented in the near future. A number of states are already moving forward with the Digital Technologies curriculum, driven by the need to equip school students with the necessary skills to enable them to be effective creators of digital solutions for the problems of the future. Nonetheless, there is a delay between the curriculum's introduction and its impact on increasing ICT skills in the Australian workforce, and a number of other countries are already ahead of us in the ICT education space. It is therefore important that the key stakeholders in this area continue to take action on developing and implementing the Digital Technologies curriculum over the coming years.

In developing and implementing any new technology-related curricula, schools and teachers will need to be supported to ensure that they have the equipment and skills required to teach students how to use and produce digital technology. For some schools, the widespread use of technology in classrooms and specific classes dedicated to computer science and computational thinking is relatively new.

The provision of educational resources by governments, industry associations and educational institutions will be a particularly important feature of curriculum implementation in these areas. International experiences in ICT education could also be drawn on as a guide for educating teachers on teaching and learning techniques.

Educational material can be used to address one of the major barriers associated with developing ICT education in Australian schools – that is, developing teacher skills and training, and their understanding of the curriculum. This understanding will be essential in ensuring that schools take a holistic approach towards introducing the curriculum, and that teaching methods are innovative and interesting for students.

Governments, universities and professional associations within each state can play a role in promoting ICT-related education and career paths to school students and parents. Organisations across all segments of the industry can play an important informational advocacy role in demonstrating to students the strength of ICT pathways in schools, as well as in universities and workplaces once students graduate from high school. This will be critical in increasing student interest in ICT, particularly in studying the technical subjects and skills that are currently in short supply in the Australian workforce.

By continuing to move in these directions, governments and industry organisations can enable schools and teachers to provide students with the education to equip them with the technical capabilities required of Australia's ICT workforce in the future. This will ensure that the future Australian workforce is suitably positioned to take advantage of the opportunities associated with digital disruption and the changing use of digital technology in the workforce.

4

Future directions

Given the increasing importance of digital technology in the Australian economy, it is clear that developing the ICT skills of Australian workers should be a key economic focus. There are a number of areas where government, education institutions, businesses and other organisations can show leadership to position the Australian workforce to take advantage of the opportunities associated with digital disruption going forward.

First, as a nation we need to focus on growing our ICT capabilities and skills in the workforce. Right now the ICT workforce is adequately supplied, however demand for ICT workers in Australia is forecast to increase by 100,000 over the next six years. As such, we must ensure that we continue to improve the quantity and quality of ICT skills in the Australian workforce. Businesses, policymakers and industry associations in the digital technology space can contribute to this goal by promoting the role of ICT in the workforce, particularly among groups with the potential to significantly increase their ICT workforce participation – such as women, mature-aged employees and workers displaced from other industries. A national conversation on the importance of ICT for future innovation and productivity growth in Australia will be essential for growing our ICT capabilities.

Governments can contribute by ensuring that the Technologies component of the new Australian Curriculum continues to be developed and implemented. This initiative requires the support of both Federal and State Governments around Australia, with all key stakeholders in the education space working to ensure that schools and teachers are educated on the new Technologies curriculum. The focus must be on equipping students with the digital literacy and computational thinking skills that will be required of the future Australian workforce in a rapidly growing digital economy.

Higher education institutions also have a key role in increasing the future pipeline of graduates with technical ICT skills, through computer science or other degrees that teach technical capabilities. This could include an informational advocacy role to demonstrate to students the strength and diversity of ICT-related career paths in an increasingly digital economy. Universities should also continue to promote interdisciplinary opportunities between ICT and other subject areas, enabling students to develop skills such as critical thinking and creative design within other fields of study.

Businesses need to recognise that on the job training is an important part of upskilling in ICT capabilities, particularly given the rapid evolution of digital technology and its use in the workforce. Many successful Australian businesses are already providing opportunities for employees to develop their ICT skills through on the job training, workshops, upskilling courses and other business development initiatives – this must increase if we are to strengthen our future workforce. Businesses can also encourage staff to rotate between IT, HR, marketing and other departments to promote the integration of ICT into wider business operations, as well as continuing to invest in ICT-related research and development in the future.

The rapidly growing digital economy means that ICT skills have an increasingly important role in Australia's labour force. Australia needs to ensure that its business practices, policy settings and education system are all working towards equipping our workforce with these skills, to enable us to face the challenges associated with digital disruption in the future.

Appendix

Statistical compendium

$78.8bn

Economic contribution of the internet and digital technologies in Australia

605,752

ICT workers in Australia

5.2%

ICT workers' proportion of total workforce

28%

Female share of ICT workers

$6.152bn

Total ICT research and development

$2.886bn

Total ICT services imports

27,547

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	$78.8bn	2013–14
ICT workers in Australia	605,752	2014
of which: ICT-related industry subdivisions	289,900	2014
Other industries	315,852	2014
of which: Technical, professional, management and operational occupations	398,014	2014
Other occupations (including trades and sales)	207,738	2014
ICT workers' proportion of total workforce	5.2%	2014
Inbound temporary migration of ICT workers (457 visas granted)	11,805	2013–14
Female share of ICT workers	28%	2014
Average weekly total cash earnings of ICT workers	$1,806	May 2014
Total ICT research and development	$6.152bn	2011–12
Total ICT services exports	$2.010bn	2014
Total ICT services imports	$2.886bn	2014
ICT university enrolments by domestic students	27,547	2013
ICT university completions by domestic students	4,886	2013

Sources: ABS cat. 5206.0 (2015), 6306.0 (2015), 8104.0 (2013), 8109.0 (2014), 8111.0 (2014) and customised report (2015); Department of Immigration, Subclass 457 Visa Statistics (2015); Department of Education u-Cube (2015)

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 (2014)	215,580	179,963	96,423	31,903	48,212	7,776	25,906
of which: ICT-related industry subdivisions	103,675	90,301	48,482	13,093	21,309	3,898	9,144
Other industries	111,905	89,662	47,941	18,810	26,903	3,878	16,762
of which: Technical, professional, management and operational occupations	144,773	118,583	59,165	20,972	31,251	4,222	19,051
Other occupations (including trades and sales)	70,807	61,380	37,258	10,931	16,961	3,554	6,855
ICT workers' proportion of total workforce (2014)	6.0%	6.2%	4.1%	4.0%	3.6%	3.3%	7.5%
ICT university enrolments by domestic students (2013)	9,161	7,765	5,424	1,474	2,057	395	1,183
ICT university completions by domestic students (2013)	1,707	1,387	823	245	410	73	223

Sources: ABS customised report (2015); Department of Education u-Cube (2015)

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
2632 ICT Support and Test Engineers

ICT technical and professional
2324 Graphic and Web Designers, and Illustrators
2611 ICT Business and Systems Analysts
2612 Multimedia Specialists and Web Developers
2613 Software and Applications Programmers
2631 Computer Network Professionals
2633 Telecommunications Engineering Professionals
3132 Telecommunications Technical Specialists

ICT sales
2252 ICT Sales Professionals
6212 ICT Sales Assistants

ICT trades
3131 ICT Support Technicians
3424 Telecommunications Trades Workers

Electronic trades and professional*
3123 Electrical Engineering Draftspersons and Technicians*
3124 Electronic Engineering Draftspersons and Technicians*
3423 Electronics Trades Workers*

ICT industry admin and logistics support*
All other occupations where the employee works in an ICT-related industry subdivision (Telecommunications Services; Internet Service Providers, Web Search Portals and Data Processing Services; and Computer System Design and Related Services)

** For these occupations, only workers employed in the ICT-related industry subdivisions (Telecommunications Services; Internet Service Providers, Web Search Portals and Data Processing Services; and Computer System Design and Related Services) are counted as ICT workers*

Source: ACS

Table A.4: ICT workers by industry and CIIER occupation grouping, 2014

	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	355	321	0	0	0	0	676
Mining	2,412	1,459	0	963	0	0	4,834
Manufacturing	6,504	9,212	720	1,774	0	0	18,210
Electricity, Gas, Water and Waste Services	5,278	2,428	208	1,884	0	0	9,798
Construction	1,693	2,401	0	4,414	0	0	8,508
Wholesale Trade	6,377	5,422	3,319	3,283	0	0	18,401
Retail Trade	4,326	3,993	6,911	3,672	0	0	18,902
Accommodation and Food Services	346	464	0	339	0	0	1,149
Transport, Postal and Warehousing	4,580	3,867	0	923	0	0	9,370
Rest of Information, Media and Telecommunications*	1,697	4,424	202	1,772	0	0	8,095
Financial and Insurance Services	21,381	16,258	0	3,888	0	0	41,527
Rental, Hiring and Real Estate Services	1,510	1,298	169	0	0	0	2,977
Rest of Professional, Scientific and Technical Services**	35,003	29,689	0	2,686	0	0	67,378
Administrative and Support Services	3,198	4,806	0	1,252	0	0	9,256
Public Administration and Safety	24,639	15,189	0	7,472	0	0	47,300
Education and Training	7,874	8,495	88	4,845	0	0	21,302
Health Care and Social Assistance	8,466	3,493	0	2,159	0	0	14,118
Arts and Recreation Services	683	3,141	0	845	0	0	4,669
Other Services	2,588	3,133	221	3,440	0	0	9,382
ICT industry subdivisions							
Telecommunications Services	11,902	16,483	7,398	18,799	707	41,296	96,585
Internet Service Providers, Web Search Portals and Data Processing Services	604	964	241	732	63	4,398	7,002
Computer System Design and Related Services	33,491	76,167	9,432	14,967	3,058	49,198	186,313
Total ICT workers	**184,907**	**213,107**	**28,909**	**80,109**	**3,828**	**94,892**	**605,752**

** 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.5: ICT employment forecast by occupation, 2014 to 2020

CIIER occupation grouping	2014	2020	Average annual growth
ICT management and operations	184,907	222,080	3.1%
ICT technical and professional	213,107	247,919	2.6%
ICT sales	28,909	35,193	3.3%
ICT trades	80,109	87,148	1.4%
Electronic trades and professional*	3,828	3,939	0.5%
ICT industry admin and logistics support*	94,892	104,205	1.6%
Total ICT workers	**605,752**	**700,483**	**2.50%**

** 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 (2015)

Table A.6: ICT skills forecast by CIIER occupation grouping, 2014 to 2020

	2014	2020	Average annual growth
ICT management and operations			
Postgraduate	64,406	84,112	4.5%
Undergraduate	125,250	159,071	4.1%
Adv dip/Dip	50,653	63,833	3.9%
Cert III/IV	30,928	39,007	3.9%
Cert I/II	14,535	17,428	3.1%
ICT technical and professional			
Postgraduate	62,660	77,948	3.7%
Undergraduate	161,591	191,057	2.8%
Adv dip/Dip	65,417	76,365	2.6%
Cert III/IV	34,004	39,714	2.6%
Cert I/II	16,293	17,769	1.5%
ICT sales			
Postgraduate	4,180	6,110	6.5%
Undergraduate	9,458	12,860	5.3%
Adv dip/Dip	4,655	6,244	5.0%
Cert III/IV	3,858	5,284	5.4%
Cert I/II	2,132	2,765	4.4%

	2014	2020	Average annual growth
ICT trades			
Postgraduate	18,571	23,356	3.9%
Undergraduate	32,842	37,410	2.2%
Adv dip/Dip	22,772	25,960	2.2%
Cert III/IV	26,281	29,526	2.0%
Cert I/II	13,924	14,161	0.3%
Electronic trades and professional			
Postgraduate	336	344	0.4%
Undergraduate	800	737	-1.3%
Adv dip/Dip	1,235	1,164	-1.0%
Cert III/IV	2,094	2,033	-0.5%
Cert I/II	831	722	-2.3%
ICT industry admin and logistics support			
Postgraduate	19,355	25,052	4.4%
Undergraduate	30,518	39,387	4.3%
Adv dip/Dip	13,114	16,744	4.2%
Cert III/IV	14,070	18,475	4.6%
Cert I/II	5,147	6,651	4.4%

Source: Deloitte Access Economics (2015)

ICT migration

Table A.7: Temporary skilled migration (457) visa grants for ICT occupations, 2010–11 to 2014–15 year to date

	2010–11	2011–12	2012–13	2013–14	2014–15*
1351 ICT Managers	759	804	902	786	452
2232 ICT Trainers	13	23	26	15	7
2247 Management and Organisation Analysts	1,489	1,767	1,396	1,239	738
2249 Other Information and Organisation Professionals	780	689	478	445	242
2252 ICT Sales Professionals	376	415	525	458	285
2324 Graphic and Web Designers, and Illustrators	326	407	477	307	230
2611 ICT Business and Systems Analysts	1,457	2,013	2,111	1,795	990
2612 Multimedia Specialists and Web Developers	48	94	141	117	97
2613 Software and Applications Programmers	5,246	5,388	4,602	4,161	2,520
2621 Database and Systems Administrators, and ICT Security Specialists	460	532	560	356	170
2631 Computer Network Professionals	197	336	276	240	127
2632 ICT Support and Test Engineers	378	668	717	671	390
2633 Telecommunications Engineering Professionals	75	240	197	53	57
3123 Electrical Engineering Draftspersons and Technicians	379	535	524	365	187
3124 Electronic Engineering Draftspersons and Technicians	174	233	197	147	67
3131 ICT Support Technicians	260	358	448	340	161
3132 Telecommunications Technical Specialists	57	315	118	61	31
3423 Electronics Trades Workers	89	222	154	88	71
3424 Telecommunications Trades Workers	40	117	103	161	41
Total ICT workers**	**12,603**	**15,156**	**13,952**	**11,805**	**6,863**

** 2014–15 data is financial year to 31 December 2014*
***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, Subclass 457 Visa Statistics (2015)

Table A.8: Net migration of ICT workers, 2011–12 to 2013–14

	2011–12	2012–13	2013–14
1351 ICT Managers	1,086	1,561	1,212
2232 ICT Trainers	28	37	45
2247 Management and Organisation Analysts	2,783	3,127	2,409
2249 Other Information and Organisation Professionals	1,161	1,278	1,217
2252 ICT Sales Professionals	735	1,106	1,254
2324 Graphic and Web Designers, and Illustrators	483	728	631
2611 ICT Business and Systems Analysts	2,062	2,609	2,503
2612 Multimedia Specialists and Web Developers	87	117	176
2613 Software and Applications Programmers	4,360	5,212	5,152
2621 Database and Systems Administrators, and ICT Security Specialists	466	669	610
2631 Computer Network Professionals	355	421	342
2632 ICT Support and Test Engineers	446	710	966
2633 Telecommunications Engineering Professionals	189	243	115
3123 Electrical Engineering Draftspersons and Technicians	746	800	730
3124 Electronic Engineering Draftspersons and Technicians	363	464	314
3131 ICT Support Technicians	466	702	667
3132 Telecommunications Technical Specialists	276	242	271
3423 Electronics Trades Workers	240	285	167
3424 Telecommunications Trades Workers	105	170	298
Total ICT workers*	**16,437**	**20,481**	**19,079**

** 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, Overseas Arrivals and Departures Statistics (2015)

ICT higher and vocational education

Table A.9: ICT workers' field of education, 2011

Field of education studied	Share of ICT workers
Information Technology	35%
Engineering and Related Technologies	22%
Management and Commerce	18%
Creative Arts	10%
Society and Culture	6%
Other	5%
Natural and Physical Sciences	4%

Source: ABS Census (2011)

Table A.10: Domestic enrolments by field of education, 2001 to 2013

Year	IT undergraduates	IT postgraduates	Engineering undergraduates	Engineering postgraduates
2001	35,661	10,161	39,705	7,109
2002	36,647	10,280	40,001	7,487
2003	35,172	9,118	39,690	8,038
2004	31,323	8,139	39,023	8,268
2005	26,527	6,923	38,213	8,218
2006	22,762	6,101	38,983	8,170
2007	20,709	5,488	40,848	8,222
2008	18,905	5,077	42,570	8,417
2009	18,545	5,143	45,142	8,806
2010	18,966	5,213	47,826	9,560
2011	19,902	5,386	49,820	9,863
2012	21,047	5,562	51,922	10,305
2013	22,055	5,447	54,896	10,649

Source: Department of Education u-Cube (2015)

Table A.11: Domestic completions by field of education, 2001 to 2013

Year	IT undergraduates	IT postgraduates	Engineering undergraduates	Engineering postgraduates
2001	5,451	2,850	6,336	1,509
2002	6,219	3,294	6,228	1,522
2003	6,580	2,588	6,246	1,674
2004	6,283	2,272	6,557	1,632
2005	5,696	1,976	6,036	1,602
2006	4,672	1,642	6,377	1,643
2007	4,185	1,474	6,153	1,808
2008	3,577	1,349	6,290	1,876
2009	3,159	1,315	6,428	1,995
2010	3,050	1,275	6,668	2,294
2011	3,266	1,353	7,105	2,306
2012	3,339	1,326	7,480	2,458
2013	3,463	1,423	7,652	2,768

Source: Department of Education u-Cube (2015)

Table A.12: VET enrolments in the IT field of education, 2009 to 2013

Year	2009	2010	2011	2012	2013
Advanced dip/dip	7,124	7,370	6,642	6,189	6,478
Cert III/IV	18,474	16,862	17,597	18,662	19,606
Cert I/II	1,089	701	915	7,682	9,299

Source: National Centre for Vocational Education Research (2015)

Women in ICT

Table A.13: Female ICT workers by industry, 2014

	Female ICT workers	Female % of ICT workers	Female % of all occupations
Industry divisions			
Agriculture, Forestry and Fishing	127	19%	30%
Mining	1,520	31%	14%
Manufacturing	5,733	31%	27%
Electricity, Gas, Water and Waste Services	2,627	27%	21%
Construction	904	11%	11%
Wholesale Trade	3,656	20%	33%
Retail Trade	4,228	22%	56%
Accommodation and Food Services	459	40%	55%
Transport, Postal and Warehousing	1,970	21%	23%
Rest of Information, Media and Telecommunications*	1,439	18%	49%
Financial and Insurance Services	11,214	27%	50%
Rental, Hiring and Real Estate Services	781	26%	50%
Rest of Professional, Scientific and Technical Services**	24,561	36%	48%
Administrative and Support Services	3,049	33%	53%
Public Administration and Safety	17,187	36%	49%
Education and Training	8,523	40%	70%
Health Care and Social Assistance	6,288	45%	78%
Arts and Recreation Services	1,254	27%	47%
Other Services	2,514	27%	43%
ICT industry subdivisions			
Telecommunications Services	26,637	28%	28%
Internet Service Providers, Web Search Portals and Data Processing Services	2,262	32%	32%
Computer System Design and Related Services	41,582	22%	22%
Total ICT workers	**168,515**	**28%**	**42%**

** 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)

ICT industry earnings

Table A.14: Average weekly total cash earnings for ICT occupations, May 2014*

	Persons	Males	Females
1351 ICT Managers	$3,015	$3,183	$2,285
2232 ICT Trainers	$1,342	N/A	N/A
2247 Management and Organisation Analysts	$1,834	$1,890	$1,740
2249 Other Information and Organisation Professionals	$1,564	$1,750	$1,395
2252 ICT Sales Professionals	$2,787	$2,918	$1,950
2324 Graphic and Web Designers, and Illustrators	$1,278	$1,444	$996
2611 ICT Business and Systems Analysts	$2,085	$2,194	$1,871
2612 Multimedia Specialists and Web Developers	$1,232	$1,199	$1,395
2613 Software and Applications Programmers	$1,825	$1,853	$1,672
2621 Database and Systems Administrators, and ICT Security Specialists	$1,827	$1,881	$1,614
2631 Computer Network Professionals	$1,916	$1,976	$1,534
2632 ICT Support and Test Engineers	$1,889	$1,995	$1,555
2633 Telecommunications Engineering Professionals	$2,313	$2,345	$2,040
3123 Electrical Engineering Draftspersons and Technicians	$1,921	$1,977	$1,495
3124 Electronic Engineering Draftspersons and Technicians	$1,891	N/A	N/A
3131 ICT Support Technicians	$1,288	$1,300	$1,240
3132 Telecommunications Technical Specialists	$1,832	$1,879	$1,496
3423 Electronics Trades Workers	$1,183	$1,178	$1,419
3424 Telecommunications Trades Workers	$1,292	$1,298	$960
6212 ICT Sales Assistants	$921	$961	$835
Total ICT workers**	**$1,806**	**$1,879**	**$1,494**

** Includes full-time and part-time workers*
***Excludes ICT industry admin and logistics support for which breakdowns are unavailable; electronic trades and professional data is for all industries*
Source: ABS cat. 6306.0 (2015)

Research and development

Table A.15: Expenditure on ICT research and development by type of organisation, 2008–09 to 2012–13

	2008–09 ($m)	2009–10 ($m)	2010–11 ($m)	2011–12 ($m)	2012–13 ($m)
Business	4,509	4,760	5,001	5,496	N/A
State Government	30	N/A	N/A	9	13
Federal Government	261	N/A	N/A	314	241
Higher education	N/A	344	N/A	331	N/A
Private non-profit	N/A	N/A	N/A	2	7

Sources: ABS cat. 8104.0 (2013), 8109.0 (2014), 8111.0 (2014)

Table A.16: Business expenditure on research and development by fields of research, 2008–09 to 2011–12

	2008–09 ($m)	2009–10 ($m)	2010–11 ($m)	2011–12 ($m)
Engineering	9,570	8,798	9,283	8,686
Information and Computing Sciences	***4,509***	***4,760***	***5,001***	***5,496***
Technology	793	769	917	941
Medical and Health Sciences	1,003	921	928	331
Agricultural and Veterinary Sciences	367	418	493	455
Chemical Sciences	266	250	275	426
Environmental Sciences	178	155	193	281
Built Environment and Design	178	202	309	232
Commerce, Management, Tourism and Services	94	99	153	144
Earth Sciences	175	153	200	122
Other fields of research	158	235	254	301

Source: ABS cat. 8104.0 (2013)

Trade in ICT services

Table A.17: Exports of ICT services, 2010 to 2014

	2010 ($m)	2011 ($m)	2012 ($m)	2013 ($m)	2014 ($m)
Telecommunications services	186	138	175	219	296
Computer services	1,269	1,306	1,217	1,356	1,423
Information services	77	59	74	111	106
Other ICT services	196	183	202	235	185
Total ICT services	1,728	1,686	1,668	1,921	2,010

Sources: ABS cat. 5302.0

Table A.18: Imports of ICT services, 2010 to 2014

	2010 ($m)	2011 ($m)	2012 ($m)	2013 ($m)	2014 ($m)
Telecommunications services	446	319	232	230	302
Computer services	1,310	1,378	1,379	1,691	2,067
Information services	55	67	98	172	207
Other ICT services	227	204	203	306	310
Total ICT services	2,038	1,968	1,912	2,399	2,886

Sources: ABS cat. 5302.0

International comparison: users of ICT across the workforce

Table A.19: Share of ICT specialists in the total economy (narrow measure of ICT users)

	1995	2010
Sweden	3.9%	5.4%
Switzerland	N/A	5.0%
Czech Republic	3.9%	4.7%
Norway	N/A	4.7%
Finland	2.7%	4.5%
Denmark	3.0%	4.4%
Luxembourg	2.9%	4.4%
Canada	3.0%	4.4%
Netherlands	3.3%	4.0%
United States	3.3%	4.0%
Australia	***3.1%***	***3.6%***
Germany	2.2%	3.5%
Iceland	N/A	3.5%
United Kingdom	2.9%	3.3%
Estonia	N/A	3.2%
Austria	2.5%	3.2%
Belgium	2.1%	3.1%
France	2.9%	3.1%
Cyprus	N/A	3.1%
Spain	2.2%	3.1%

	1995	2010
Italy	2.4%	3.1%
Slovenia	N/A	3.0%
Slovak Republic	N/A	2.9%
Malta	N/A	2.9%
Ireland	2.8%	2.8%
Poland	N/A	20.4%
United States	21.2%	20.3%
Spain	15.8%	19.5%
Poland	N/A	2.8%
Latvia	N/A	2.7%
Hungary	N/A	2.7%
Portugal	2.8%	2.6%
Bulgaria	N/A	2.4%
Romania	N/A	2.3%
Greece	2.2%	2.2%
Croatia	N/A	2.0%
Turkey	N/A	1.7%
Lithuania	N/A	1.6%
FYR Macedonia	N/A	1.5%

Source: OECD, Information Technology Outlook (2010)

Table A.20: Share of ICT-intensive jobs in the total economy (broad measure of ICT users)

	1995	2010
Luxembourg	23.0%	35.3%
United Kingdom	27.8%	28.1%
Denmark	20.4%	27.3%
Lithuania	N/A	26.9%
Sweden	20.4%	26.5%
Malta	N/A	26.3%
Finland	20.0%	25.5%
Estonia	N/A	24.1%
Norway	N/A	24.1%
Slovenia	N/A	24.0%
Ireland	14.5%	24.0%
Latvia	N/A	24.0%
Switzerland	N/A	23.6%
Netherlands	23.0%	23.5%
Iceland	N/A	23.0%
Czech Republic	18.6%	22.8%
Belgium	18.7%	22.7%
Cyprus	N/A	22.7%

	1995	2010
Germany	20.4%	22.5%
Hungary	N/A	22.5%
Australia	***21.7%***	***22.1%***
Canada	20.6%	21.2%
Austria	15.1%	20.8%
Slovak Republic	N/A	20.8%
France	18.6%	20.7%
Italy	20.9%	20.4%
United States	21.2%	20.3%
Spain	15.8%	19.5%
Poland	N/A	19.5%
Croatia	N/A	16.1%
Greece	10.3%	15.2%
Bulgaria	N/A	15.0%
Portugal	16.4%	15.0%
Romania	N/A	11.8%
Turkey	N/A	10.9%
FYR Macedonia	N/A	9.4%

Source: OECD, Information Technology Outlook (2010)

International comparison: ICT research and development

Table A.21: ICT research and development as a share of total research expenditure

	ICT R&D*	Year**
Chinese Taipei	73%	2013
Korea	54%	2013
Ireland	36%	2011
United States	32%	2011
Singapore	30%	2011
Canada	27%	2013
Norway	25%	2012
Turkey	25%	2013
Estonia	25%	2012
Portugal	24%	2012
Romania	23%	2012
Hungary	19%	2012
New Zealand	19%	2011
Japan	18%	2013
Italy	18%	2012
France	17%	2012
United Kingdom	16%	2012
Czech Republic	15%	2012
Belgium	15%	2011
Spain	15%	2012
Denmark	14%	2012
Netherlands	14%	2012
Germany	12%	2012
Austria	12%	2011
Slovenia	10%	2012
Australia	***10%***	***2011***
Finland	9%	2012
Poland	2%	2012

** ICT R&D calculated as the sum of R&D in the following industries under ISIC Rev. 4 classifications: D261, D262, D263, D582, D61, D62, D63.*
*** Latest available year*
Source: OECD, STAN R&D Expenditures in Industry (2015)

Table A.22: ICT-related patents as a share of total patents, 2011

	ICT patents
Finland	54.5%
Korea	48.8%
Sweden	48.6%
Israel	45.3%
Canada	43.8%
Japan	42.7%
Ireland	42.3%
Estonia	41.7%
United States	40.3%
United Kingdom	33.0%
Hungary	32.8%
Netherlands	30.5%
Portugal	29.4%
France	29.2%
Australia	***27.7%***
Greece	27.5%
Belgium	26.6%
Spain	26.4%
Poland	24.4%
Germany	23.7%
Switzerland	23.0%
Austria	21.8%
Denmark	21.2%
Luxembourg	20.8%
Norway	20.8%
New Zealand	19.1%
Italy	16.8%
Slovenia	16.0%
Mexico	15.1%
Slovak Republic	14.5%
Iceland	13.8%
Turkey	12.6%
Czech Republic	12.5%
Chile	9.2%

Source: OECD, Broadband Portal (2014)

International comparison: ICT investment

Table A.23: Contribution of ICT investment to GDP growth in percentage points, average annual growth from 2000 to 2012

	ICT investment (ppt)	Non-ICT investment (ppt)
Denmark	0.55	0.41
New Zealand	0.48	0.41
Australia	***0.46***	***1.01***
Sweden	0.44	0.32
Portugal	0.40	0.70
Switzerland	0.39	0.18
Belgium	0.39	0.31
Netherlands	0.38	0.46
United Kingdom	0.38	0.42
United States	0.34	0.29
Korea	0.33	0.87
Austria	0.32	0.36
Japan	0.31	0.11
Spain	0.30	0.66
Canada	0.29	0.45
Germany	0.26	0.15
Ireland	0.24	0.79
France	0.23	0.34
Finland	0.20	0.18
Italy	0.17	0.32

Source: OECD, Productivity Database (2014)

Table A.24: ICT investment by asset as a percent of GDP, 2012*

	Software	IT equipment	Communication employees	Breakdown not available
Denmark	2.1%	N/A	N/A	1.4%
Japan	2.0%	N/A	N/A	1.3%
Switzerland	2.2%	0.5%	0.6%	N/A
Sweden	2.5%	0.6%	0.1%	N/A
New Zealand	1.4%	0.8%	1.0%	N/A
United States	2.0%	0.6%	0.6%	N/A
Austria	1.8%	0.5%	0.8%	N/A
Belgium	1.5%	1.1%	0.4%	N/A
Korea	1.7%	0.3%	0.7%	N/A
Australia	***1.0%***	***0.9%***	***0.7%***	***N/A***
United Kingdom	1.9%	N/A	N/A	0.7%
Portugal	1.2%	0.7%	0.6%	N/A
France	1.9%	0.3%	0.2%	N/A
Spain	1.2%	0.4%	0.7%	N/A
Canada	1.2%	0.6%	0.4%	N/A
Czech Republic	1.1%	0.8%	0.3%	N/A
Netherlands	1.3%	0.7%	N/A	N/A
Slovenia	1.0%	0.7%	0.4%	N/A
Finland	1.1%	0.3%	0.3%	N/A
Italy	0.9%	0.4%	0.3%	N/A
Germany	0.8%	0.4%	0.3%	N/A
Greece	0.3%	0.6%	0.6%	N/A
Ireland	0.7%	0.3%	0.3%	N/A
Mexico	0.4%	0.3%	0.5%	N/A
Slovak Republic	0.6%	0.3%	0.3%	N/A
Luxembourg	0.3%	0.5%	0.3%	N/A

** 2012 or latest available year*

Source: OECD, Annual National Accounts Database (2014)

International comparison: trade in ICT goods

Table A.25: ICT goods exports and imports

	Exports (2012, USD $m)	Imports (2009, USD $m)
United States	138,651	230,627
Korea	93,260	41,855
Japan	72,781	62,726
Mexico	62,414	45,938
Germany	61,850	78,036
Netherlands	55,840	54,858
France	22,606	38,233
Czech Republic	22,361	16,458
United Kingdom	20,080	47,596
Hungary	17,872	16,199
Slovak Republic	13,281	8,429
Poland	12,609	14,609
Sweden	12,438	12,677
Canada	10,249	27,012
Italy	9,339	24,560
Belgium	9,108	13,595
Israel	7,387	4,605
Ireland	6,762	8,294
Austria	6,112	8,148
Denmark	3,680	6,561
Spain	3,609	28,238
Switzerland	3,247	8,896
Finland	2,899	6,193
Turkey	2,645	7,078
Australia	***2,241***	***16,699***
Estonia	1,977	636
Portugal	1,972	4,367
Norway	1,278	5,247
Greece	592	3,659
Slovenia	484	1,109
New Zealand	419	2,202
Luxembourg	374	978
Chile	265	2,689
Iceland	8	143

Source: OECD, Communications Outlook (2011) and ICT goods exports indicator (2015)

International comparison: business ICT use and e-commerce

Table A.26: Share of businesses with broadband connectivity by size, 2013

	All enterprises	10–49 employees	50–249 employees	250+ employees
Finland	99.7%	99.7%	100.0%	100.0%
Korea	98.6%	98.4%	99.8%	99.6%
France	98.6%	98.4%	99.8%	99.8%
Denmark	98.4%	98.2%	99.3%	99.8%
Iceland	98.4%	98.0%	100.0%	100.0%
Switzerland	98.1%	97.7%	99.5%	99.7%
Canada	98.1%	97.7%	99.4%	99.8%
Netherlands	97.7%	97.3%	99.3%	100.0%
Slovenia	97.4%	96.8%	99.8%	100.0%
Sweden	96.9%	96.5%	99.0%	98.8%
Luxembourg	96.8%	96.2%	99.2%	100.0%
Estonia	96.4%	95.9%	98.7%	100.0%
Australia	***96.4%***	***96.1%***	***97.6%***	***99.7%***
Spain	96.4%	96.0%	98.9%	99.8%
New Zealand	95.9%	95.9%	96.2%	95.0%
United Kingdom	95.3%	94.5%	99.5%	98.8%
Belgium	95.3%	94.6%	98.5%	99.1%
Czech Republic	95.2%	94.3%	98.5%	99.3%
Italy	94.8%	94.3%	98.5%	99.4%
Ireland	94.6%	93.8%	98.6%	98.6%
Austria	93.4%	92.4%	98.3%	100.0%
Portugal	93.2%	92.3%	97.6%	100.0%
Germany	92.6%	91.3%	97.1%	99.1%
Norway	92.1%	91.5%	95.9%	97.7%
Slovak Republic	90.9%	89.5%	95.0%	98.0%
Turkey	90.6%	89.2%	96.7%	98.8%
Hungary	87.1%	85.4%	95.5%	98.3%
Japan	84.0%	N/A	84.6%	82.8%
Poland	82.6%	79.7%	94.6%	99.5%
Greece	78.1%	75.8%	94.3%	96.9%

Source: OECD, ICT Database (2014)

Table A.27: Share of businesses with a website by size, 2013

	All enterprises	10–49 employees	50–249 employees	250+ employees
Finland	93.6%	92.5%	98.2%	99.1%
Denmark	91.8%	91.1%	94.5%	96.4%
Switzerland	91.7%	90.5%	95.7%	99.1%
Sweden	88.9%	87.1%	98.1%	98.5%
Japan	88.6%	N/A	85.9%	94.3%
Austria	85.7%	83.9%	93.8%	98.3%
Germany	84.4%	82.4%	91.7%	95.8%
Netherlands	83.8%	81.7%	91.6%	96.4%
Iceland	82.7%	80.3%	92.8%	100.0%
United Kingdom	82.0%	79.6%	92.9%	96.5%
Czech Republic	79.9%	76.7%	92.4%	92.2%
Slovenia	79.7%	76.1%	92.5%	99.5%
Slovak Republic	79.6%	78.5%	83.1%	84.5%
Norway	79.0%	77.0%	90.5%	93.2%
Luxembourg	78.6%	75.8%	88.1%	96.6%
Belgium	78.3%	75.7%	90.2%	94.2%
New Zealand	78.0%	75.7%	89.4%	95.6%
Canada	77.5%	73.7%	88.8%	91.5%
Estonia	75.7%	72.9%	87.2%	94.0%
Ireland	74.7%	71.1%	90.7%	97.3%
Australia	***74.1%***	***73.1%***	***77.8%***	***96.7%***
Spain	68.4%	65.4%	85.9%	93.2%
Italy	67.2%	65.2%	82.7%	90.2%
Poland	66.0%	61.3%	85.2%	91.9%
France	65.3%	61.5%	86.7%	93.9%
Hungary	61.2%	58.1%	76.4%	82.1%
Greece	60.6%	57.6%	81.8%	91.5%
Korea	60.1%	57.4%	73.4%	87.9%
Portugal	59.2%	54.4%	84.8%	97.0%
Turkey	53.8%	50.0%	68.5%	83.2%

Source: OECD, ICT Database (2014)

Table A.28: Share of businesses engaged in sales via e–commerce by size, 2012

	All enterprises	10–49 employees	50–249 employees	250+ employees
New Zealand	47.4%	46.8%	49.6%	58.1%
Australia	***38.4%***	***38.6%***	***36.5%***	***41.0%***
Switzerland	34.5%	33.8%	34.8%	52.0%
Iceland	33.8%	29.9%	52.4%	55.1%
Denmark	29.8%	27.4%	37.7%	56.4%
Norway	27.6%	25.5%	38.2%	47.4%
Czech Republic	27.0%	25.2%	31.9%	44.0%
Germany	25.8%	23.5%	32.6%	48.4%
Sweden	25.7%	23.5%	33.6%	54.2%
Japan	24.6%	N/A	22.9%	28.1%
Ireland	23.3%	19.2%	42.2%	43.4%
Netherlands	22.1%	19.9%	29.4%	40.7%
United Kingdom	21.7%	19.4%	29.6%	46.3%
Belgium	21.1%	18.9%	28.6%	46.7%
Slovak Republic	19.8%	18.6%	20.7%	36.0%
Finland	19.3%	15.6%	31.8%	48.8%
Canada	18.5%	16.5%	23.4%	29.2%
Luxembourg	17.1%	15.9%	19.4%	33.7%
Austria	16.4%	13.9%	25.9%	42.9%
Slovenia	15.4%	12.6%	22.4%	47.7%
Korea	15.3%	14.1%	19.9%	34.9%
Portugal	14.7%	12.7%	24.6%	36.9%
Spain	14.3%	12.4%	24.2%	32.7%
France	13.8%	11.1%	27.3%	43.2%
Hungary	12.8%	11.7%	16.4%	28.6%
Estonia	12.7%	10.7%	19.6%	30.9%
Poland	10.7%	8.9%	15.7%	33.3%
Turkey	10.1%	9.2%	12.6%	21.6%
Greece	10.0%	8.8%	18.0%	19.8%
Italy	7.5%	6.8%	11.9%	24.6%

Source: OECD, ICT Database (2014)

International comparison: access to digital technology

Table A.29: Mobile wireless broadband penetration, 2013

	All mobile wireless broadband technologies (subscriptions per 100 inhabitants)
Finland	123.3
Australia	***114.4***
Japan	111.8
Sweden	109.8
Denmark	107.3
Korea	103.8
United States	100.7
Estonia	90.8
Norway	90.4
Luxembourg	86.1
New Zealand	85.9
United Kingdom	77.2
Iceland	76.5
Ireland	69.2
Spain	68.5
Italy	65.3
Austria	64.7
Switzerland	64.2
Netherlands	64.2
Czech Republic	62.5
Poland	61.3
France	55.9
Slovak Republic	55.3
Canada	53.3
Israel	50.5
Belgium	46.0
Germany	45.1
Slovenia	42.4
Portugal	37.5
Greece	36.2
Chile	35.8
Turkey	32.3
Hungary	27.7
Mexico	14.0

Source: OECD, Broadband Portal (2014)

Table A.30: Share of population using the internet by age, 2013*

	Total users (16–74 years)	Younger users (16–24 years)	Older users (65–74 years)
Iceland	96.5%	100.0%	78.7%
Norway	95.1%	100.0%	70.5%
Sweden	94.8%	98.3%	76.4%
Denmark	94.6%	99.6%	76.9%
Netherlands	94.0%	100.0%	76.4%
Luxembourg	93.8%	99.6%	76.1%
Finland	91.5%	99.7%	65.4%
Switzerland	90.4%	99.3%	68.5%
United Kingdom	89.8%	99.2%	63.9%
Japan	88.7%	98.1%	68.0%
Korea	87.9%	99.9%	33.7%
Canada	87.6%	98.6%	59.7%
Australia	***87.5%***	***96.5%***	***58.2%***
New Zealand	85.0%	93.0%	61.0%
Germany	84.0%	98.0%	49.9%
Belgium	82.2%	96.8%	47.9%
France	81.9%	97.1%	46.5%
Austria	80.6%	99.2%	33.9%
Estonia	80.0%	98.2%	31.1%
OECD	78.9%	95.0%	43.9%
Ireland	78.2%	94.6%	34.6%
Slovak Republic	77.9%	99.6%	23.4%
United States	76.2%	86.0%	51.4%
Czech Republic	74.1%	94.4%	27.0%
Israel	74.1%	84.6%	48.7%
Slovenia	72.7%	98.0%	24.4%
Hungary	72.6%	95.3%	22.5%
Spain	71.6%	97.4%	22.1%
Chile	70.7%	97.7%	24.1%
Poland	62.8%	96.7%	16.3%
Portugal	62.1%	98.0%	18.6%
Greece	59.9%	93.0%	9.5%
Italy	58.5%	85.4%	17.6%
Turkey	43.2%	68.7%	4.2%
Mexico	41.7%	68.1%	6.3%

** Internet use measured over a period of 3 to 12 months depending on country*

Source: OECD, ICT Database (2014)

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MCBD_Hyd_06/13_51714