

Industry Skills Forecast and Proposed Schedule of Work

Information and
Communications Technology

May 2019



www.pwc.com.au

Executive summary

The Information and Communications Technology (ICT) sector comprises workers involved in information technology (IT), communications technology and digital media. The ICT sector provides services to Australian households, businesses and organisations to allow them to be more informed, more productive and more connected. In 2018, there were approximately 504,000 workers in the Australian ICT sector.¹ By 2023, this is expected to grow by 13.4 per cent – adding over 67,800 jobs to the economy.²

Nationally recognised training products for this sector are housed within the ICT Training Package, which provides the competency standards for learners working, or seeking work, in the sector. PwC's Skills for Australia and the ICT Industry Reference Committees (IRC) have undertaken, and continue to undertake, projects to address new and emerging skills needs in the ICT sector.

In addition to these, this proposed schedule of work for 2019-20 sets out Project 4: Getting a more specialised job in telecommunications. This project proposes to update outdated training products to address the convergence of IT and telecoms job roles and skills, pressure to upskill and reskill as telecoms evolves, and greater recognition of enterprise and commercial skills affecting Telecommunications Technical Specialists and Telecommunications Engineering Professionals



Contents

Executive summary	2
1 Sector overview	5
1.1 The sector at a glance	5
1.2 Training Package at a glance	5
2 Employment and skills outlook	7
2.1 Employment outlook	7
2.2 Skills outlook	7
3 Key drivers for change and proposed responses	9
3.1 Key drivers for change overview	9
3.2 Proposed responses	12
4 Consultation undertaken	14
5 Proposed schedule of work overview	16
6 2019-20 Project details	17
6.1 Project 4: Getting a more specialised job in telecommunications	17
7 IRC Sign off	22
Appendices	23
Appendix A Administrative Information	24
Appendix B ICT Training Package profile	25
Appendix C Stakeholder consultations	27



Skills Forecast

1 Sector overview

1.1 The sector at a glance

The Information and Communications Technology (ICT) sector encompasses a range of businesses and workers involved in information technology (IT), communications technology and digital media. The activities undertaken by ICT workers are broad in nature, ranging from planning and commissioning communications infrastructure, such as the optical networks rolled out under the National Broadband Network (NBN), to designing and developing the digital content that users consume over these networks, such as websites, mobile applications and video games.

ICT workers are also responsible for designing, developing and maintaining the software layers that allow information to be retrieved, stored, transmitted and manipulated. This means that the sector is responsible for connecting Australian households, businesses and organisations to each other and to the rest of world across an evolving landscape of digital technologies. The sector can be broadly grouped in to three sub-sectors, set out below.

Information technology

Workers in IT use computers to retrieve, store, transmit and manipulate information. IT workers undertake various tasks ranging from designing and developing software applications and systems to meet users' business needs to planning, developing and administering organisations' database management systems.

Communications technology

Workers in communications technology, also referred to as telecommunications (telecoms), plan, design, commission and maintain software and hardware networks, including copper, optical, radio frequency and internet protocol (IP) networks. Telecoms workers undertake a range of tasks from installing and repairing hardware in households and businesses to designing and developing software to maximise the efficiency and efficacy of communication networks.

Digital media

Workers in digital media plan, design and develop digitally delivered information for promotional, instructional and entertainment purposes. Digital media workers undertake various activities from designing and developing mobile applications or video games to planning, developing and implementing social media campaigns.

1.2 Training Package at a glance

1.2.1 Training Package description and use

Of the estimated 4.2 million learners enrolled in vocational education and training (VET) qualifications in 2017, over 80,000 were enrolled in ICT qualifications (1.9 per cent of all VET learners).³ Enrolments by sub-sector are shown in Table 1 and 7Appendix B sets out enrolments in each individual ICT qualification. This shows that the majority (83 per cent) of enrolments are in IT qualifications.

Table 1: 2017 ICT Enrolments by qualification and sub-sector

	Qualification						
	Cert. I	Cert. II	Cert. III	Cert. IV	Dip.	Adv. Dip.	Grad.
Information Technology	14,495	12,785	16,435	9,855	10,995	2,330	10
Telecommunication Technology	-	1,615	6,775	385	45	105	40
Digital Media	-	-	-	900	3,510	-	-

Source: Department of Jobs and Small Business (2018) *2018 Occupational Projections – five years to May 2023*
 Note: 'Grad.' encompasses enrolments for both Graduate Diploma and Graduate Certificate qualifications.

1.2.2 Challenges and opportunities with the Training Package

Based on our analysis and industry consultation to date, there are two key opportunities and challenges for employers and learners engaging with the ICT Training Package:

- **Graduates with vendor certifications are highly sought after.** Increased recognition of vendor certifications presents both challenges and opportunities for the ICT Training Package. Industry consultation indicates that vendor certifications, such as those provided through Microsoft, Amazon Web Services (AWS) and Cisco, have become the industry standard across many ICT job roles.⁴ This is also reflected in a survey of ICT employers in 2017, showing a higher use and satisfaction with unaccredited training compared to other industries.⁵ Stakeholders have stated that there is therefore an opportunity to foster greater recognition of vendor certifications alongside vocational training. This feedback has prompted the creation of a Vendor Certification Working Group, which considers how vendor certifications might be better accommodated in the vocational training system and reports to the ICT Industry Reference Committee (IRC).
- **Employers demand higher level qualifications.** In 2017, 58.4 per cent of ICT graduates were employed within six months of graduating, 18.5 per cent lower than the average across all VET graduates.⁶ Instead of going into employment, many graduates from the ICT Training Package will go on to undertake further training.⁷ Industry feedback suggest this is because ICT learners require a higher level of qualification to gain employment and employers have difficulty finding graduates with appropriate ICT skills and knowledge.⁸ The fact that learners tend to undertake further vocational training presents an opportunity for more specialised training at higher Australian Qualification Framework (AQF) level qualifications that builds on the knowledge and skills established in lower AQF level qualifications. This is being addressed by current projects and the projects proposed in this document.

1.2.3 Training Package collaboration opportunities

The Australian Industry Skills Committee (AISC) has identified several cross sector skill areas where opportunities exist to create flexible and transferable package components that will benefit industry, learners and the broader VET sector. These include projects such as: big data, cyber security, teamwork and communication and consumer engagement through online and social media.

The ICT Training Package already houses many areas of core skills used across other industries and Training Packages. Where applicable, these are set out in the context of the projects in the proposed schedule of work. PwC's Skills for Australia and the ICT IRC will continue to look for, and participate in, opportunities for collaboration across industries where available.

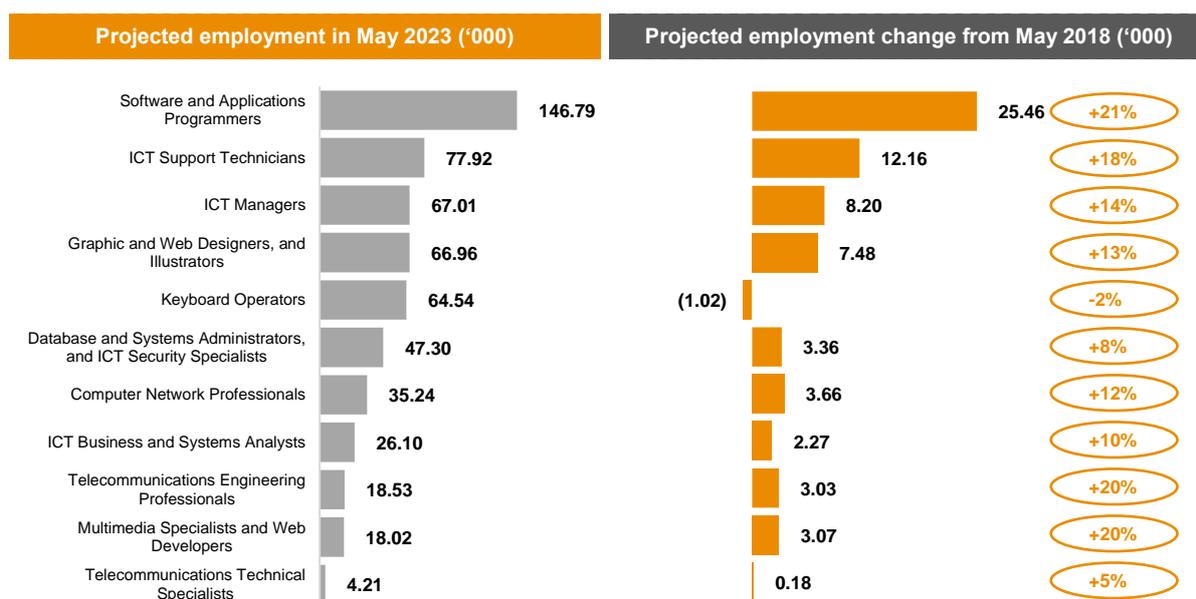
By way of example, skills from the cyber security and cross sector project are relevant to many roles in ICT, particularly where workers are dealing with sensitive data, such as personal information. Across these job roles, maintaining robust and consistent data management practices is critical to protecting sensitive data and mitigating cyber threats.

2 Employment and skills outlook

2.1 Employment outlook

Consistent with previous Industry Skills Forecasts, employment projections for the ICT sector are represented by a range of occupation divisions (as defined by ANZSCO) which align to job roles in the ICT sector, as below.

Figure 1: Projected employment levels for ICT occupations



Source: Department of Jobs and Small Business (2018) 2018 Occupational Projections – five years to May 2023

This shows growth in employment almost universally across ICT occupations, showing strong demand for these skills in to the future. In the next five years, this forecast shows that the ICT sector will add over 67,800 jobs to the economy.⁹

2.2 Skills outlook

2.2.1 Current and emerging skills needs

The current and emerging skills required in the ICT sector largely depend on the sub-sector that a particular worker is in and the role they hold within that sub-sector. At a high level, a worker in the ICT sector will need two specific sets of skills:

- **Technical skills**, which are typically specific to sub-sector in which the worker operates. For example, while many job roles will require software programming skills, other job roles, such as field operations roles in telecoms, will require skills commissioning and maintaining hardware, such as cabling, satellites and radio equipment. The following examples further illustrate how skill sets may vary depending on sub-sector:
 - **ICT Managers** need skills including analysing information needs and specifying technology to meet those needs; formulating and directing ICT strategies; directing the selection and installation of ICT resources and the provision of user training; and overseeing the security of ICT systems.¹⁰

- **Multimedia Specialists and Web Developers** need skills including analysing, designing and developing internet sites; applying artistry and creativity with software programming and scripting language; communicating with network specialists regarding web-related issues; and developing and integrating computer code with other specialised inputs.¹¹
- **Telecommunications Engineering Professionals** need skills including planning, designing, commissioning and maintaining telecommunications devices, networks and infrastructure; evaluating and procuring new products and services from vendors; identifying and analysing problems and needs of existing systems; and determining appropriate configurations of hardware and software to ensure desired performance.¹²
- **Enterprise skills**, such as teamwork, communication, problem solving, and work health and safety skills that are about ‘how’ a worker operates in the workplace. These skills can be transferable across roles in the ICT sector, or can be contextualised or specialised to a particular role.

Due to consistent change and evolution of technology in the sector (covered in more detail in Section 3 below), the technical skills required to keep pace will be a key focus for the sector. In ICT – and many other sectors – employers are demanding skills that will deliver on the promises of new and emerging technologies, including advanced skills in data analytics, software engineering and cloud computing. Additionally, industry continue to support demand for enterprise skills – emphasising there is little value in a worker possessing advanced technical knowledge and skills if they unable to communicate effectively, work in a team, and demonstrate leadership.

2.2.2 Key generic skills

The ICT IRC is required to rank a supplied list of 12 generic workforce skills in order of importance to relevant employers. For the ICT sector, these skills have been ranked below in Table 2.

All skills listed in Table 2 are important. Low ranking does not imply that the skill is not important, but rather lower ranking only indicates that the skill is not a critical priority for the ICT sector. Further, Table 2 only shows rankings of importance as an average across the whole sector. Some skills may have higher or lower importance for particular organisations and particular sub-sectors.

Table 2: Ranking of generic workforce skills

Rank	Generic workforce skill
1	Technology
2	Science, technology, engineering and maths (STEM)
3	Design mindset/ Thinking critically/ System thinking/ Solving problems
4	Learning agility/ Information literacy/ Intellectual autonomy and self-management
5	Communication/ Virtual collaboration/ Social intelligence
6	Language, literacy and numeracy (LLN)
7	Customer service/ Marketing
8	Entrepreneurial
9	Data analysis
10	Managerial/ Leadership
11	Financial
12	Environmental and sustainability

Source: Formal activity undertaken by IRC members, confirmed 1 May 2019

Note: Generic Workforce Skills have been ranked in line with the definitions provided by the Department of Education and Training.

3 Key drivers for change and proposed responses

3.1 Key drivers for change overview

This section provides an overview of key drivers for change in the Australian ICT sector. These drivers will likely lead to movements in the employment landscape (i.e., the number and nature of jobs roles available), as well as the skills needed to succeed in those future job roles.

3.1.1 Changing technology

The ICT sector is defined by the current rapid evolution of technology. The sector plays a fundamental role in delivering skills that facilitate rapid and widespread technological change throughout the economy both within ICT and in every other industry. As computing power and global data volume continue to exhibit exponential growth,¹³ the technological change is faster and more widespread than ever before. While many emerging technologies are now household names, such as artificial intelligence (AI), virtual reality (VR) and augmented reality (AR) and the Internet of Things (IoT), it is not known how they will impact the Australian and global economy in years to come. However, it is anticipated that ICT job roles and skills will be necessary to harness the potential of new and emerging technologies. This includes highly specialised skills, such as in data analytics and software engineering to design, develop and implement new technology, as well as digital literacy, creativity and communication skills to work effectively in future economy that is set to be more automated and digitally connected than ever before.

New automation technologies are set to transform the economy

Automation technologies, including AI and robotic process automation (RPA) are anticipated to deliver significant benefits to productivity, income and economic growth as they reach scale in the coming decades.¹⁴ Driven by advances in computing power and exponential growth in global data volumes, automation technologies already play a part in the lives of consumers, businesses and organisations – from filtering email spam or personalising products recommendations online to programmatically coordinating supply chains and scheduling asset maintenance on demand. By 2030, it is estimated that between 25 and 46 per cent of current work activities could be automated in Australia.¹⁵ Automation is expected to impact job roles and skills across all industries in Australia – from asset-intensive sectors such as mining, agriculture and manufacturing to services sectors such as healthcare, professional services and education.¹⁶ While automation impacts will vary substantially across sectors and job roles, it is important to note that automation will impact white collar and service sector work – not just blue collar and manual work. For example, it is estimated that 13 per cent of a surgeon's and 23 per cent of a lawyer's time can already be automated, including activities such as analysing patient data, legal research and document preparation.¹⁷ From 2016 to 2030, it is predicted that the amount of hours a worker spends on physical and manual skills and basic cognitive skills will decline by 11 per cent and 2 per cent respectively, while the amount of hours will increase for higher cognitive (18 per cent), social and emotional (43 per cent) and technological (66 per cent) skills.¹⁸

Job roles and skills in ICT lie at the heart of the automation transformation. Industry stakeholders indicate that job roles such as data analysts, data scientists and software engineers will be in great demand not only in IT, telecoms and digital media businesses, but across industry to lead and execute automation initiatives in-house. As many physical, manual and basic cognitive tasks are automated across ICT job roles, industry recognition for enterprise skills, such as teamwork, empathy and problem-solving, will invariably increase as these skills are much more difficult and costly to automate.

5G and IoT promise to revolutionise communications

Fifth generation mobile network (5G) technology is widely regarded as the next technical frontier in communications, promising to revolutionise the way consumers and businesses use mobile technology.¹⁹ Firstly, 5G's increased throughput capacity is set to provide ultra-fast mobile broadband speeds and services, such as AR and VR.²⁰ Secondly, its reduced radio delay is expected to provide

delay-sensitive communication such as autonomous transport and mission-critical applications (e.g., drones used in emergency services).²¹ Lastly, 5G's higher network capacity is anticipated to enable wider and deeper coverage for massive IoT connections across a large number of low powered devices, such as in smart factories, homes and cities.²² As such, 5G technology is set to increase the scale and performance of IoT products and services, which in Australia are already valued at \$19 billion and are growing at a 14 per cent compound annual growth rate.²³

Over the next decade, 5G and IoT technology are not only anticipated to impact job roles and skills in the ICT sector, but many other industries that will benefit from associated improvements to productivity, including construction, mining, healthcare, agriculture and manufacturing.²⁴ In particular, within telecoms, new skills will likely be required to plan, design, commission and maintain public and enterprise networks in the coming years. Industry suggests that while some new skills are foreseeable – such as those required in field operations job roles to roll out and upgrade infrastructure (e.g., mobile towers and small cells in high-density areas) to facilitate 5G, others are less foreseeable – such as those required to work with communications technologies that are more interconnected and software-driven than ever before.

3.1.2 Cyber security

Cyber security has become a key issue for businesses across the economy, with PwC's CEO survey showing that 73 per cent of Australian CEOs view cyber as a top threat to growth.²⁵ To address this threat effectively, the ICT sector must not only ensure their workforce is cyber secure, create and maintain data secure systems and effectively respond to threats, but the sector also stay abreast of regulatory changes in data privacy and security on global and domestic front.

Cyber risk is high and rising for ICT businesses

Cyber security threats to the sector, both from within Australia and from abroad, are receiving greater recognition from businesses. ICT businesses represent a natural target for cyberattacks due massive volumes of personal data they hold about subscribers.²⁶ Beyond legal, financial and operational risks, cyber security breaches can result in lasting reputational damage and erosion of customer confidence. Cyber risks are also particularly acute among telcos, breaches to core communications infrastructure has national security implications for households, businesses and Government.

In response, many ICT businesses are reducing their reliance on cyber security consultants and investing in their own in-house cyber capabilities. For example, Telstra is building dedicated security centres that provide insight and advice to customers while also facilitating cooperation with local and global intelligence communities.²⁷ Similarly, Optus continues to invest in its in-house capabilities, as seen with its acquisition of cyber security firm Trustwave in 2015²⁸ and Hivint in October 2018.²⁹ Beyond investment in cyber security specialists, industry consultation suggests existing workforces are also being upskilled in data security and privacy awareness to ensure their operations are cyber secure. Increased recognition of cyber security has two implications for job roles and skills in ICT. Firstly, there is increased demand for cyber security and big data management specialists – across many industries – but particularly those that handle massive volumes of highly sensitive personal data, such as IT and telecoms businesses. Secondly, generalist skills and awareness in cyber security and big data management are required across workers in non-technical job roles to ensure sensitive data is consistently and securely inputted, retrieved, transmitted and manipulated.

The regulatory landscape is changing and the future remains uncertain

The regulatory environment surrounding cyber remains uncertain, on both domestic and international fronts. Domestically, the Federal Government is beginning to play a more active role in ensuring the security of telecoms infrastructure. The Government has commenced provisions on the Telecommunications and Other Legislation Amendment, which requires carriers to notify the government of any network or service changes that have potential national security implications.³⁰ Federal Government has also taken more direct measures to address potential national security threats, as seen in banning Huawei from providing 5G mobile infrastructure in Australia due to concerns about the company's affiliation with the Chinese government.³¹

Due to their interconnected nature and reliance on international standards in their operations, ICT businesses must also stay abreast of regulatory change on a global level. In 2018, the Network and Information Security Directive (NISD) as well as the General Data Protection Regulation (GDPR) were

implemented in the EU.³² While the GDPR is more general in nature – imposing requirements on companies to protect personal data – the NISD is a more specific measure to ensure ‘essential services providers’ (such as telcos) notify regulators whenever a cyber incident has a significant impact on their operations.³³ ICT businesses are also expected to be called upon to help organisations in all industries meet these requirements. Overall, industry feedback indicates that an uncertain regulatory environment continues to impress the need for ICT workers to be equipped with consistent and robust skills in cyber security and big data management – regardless of whether they are in highly technical roles or not.

3.1.3 Evolving business models

Globally, increased price-based competition and a lack of differentiation is shifting ICT businesses towards commoditisation.³⁴ This pressure is also being felt in the Australian sector, driving firms to cut costs to improve profitability and redefine how they deliver value to customers.³⁵ For job roles and skills in telecoms, this translates to a greater emphasis on customer service and harnessing technology to address customer needs in new and unique ways, consistent with themes observed across the IT and digital media in recent years.

Increased price-based competition

In recent years, consumption patterns suggest that despite having a greater appetite for data – owing to the proliferation of digital mass media – customers are generally unwilling to pay higher prices for greater data allowances and faster download speeds. In particular, three factors are contributing to this trend:

- **Mobile and broadband prices have declined.** In 2017, fixed and wireless broadband prices declined year-on-year by 9.4 per cent and 6.7 per cent, respectively.³⁶ Since 2013, this represents an overall decline of 4.5 per cent for fixed and 5.5 per cent for wireless.³⁷ Similarly, mobile services prices declined by 3.1 per cent in 2017, representing a 7.1 per cent drop since 2013.³⁸
- **Data allowances have risen significantly.** In 2017 alone, data allowances for mobile services and wireless broadband grew by 46 per cent and 86 per cent, respectively.³⁹ Of all fixed broadband plans, the proportion of those offering unlimited data rose to 26 per cent (up from 5 per cent in 2014).⁴⁰ Overall, data downloads grew by 43 per cent in 2017.⁴¹
- **Download speeds have improved overall.** In particular, average mobile download speed in Australia has increased 7–9 times from 2010 to 2017, due to the rollout and upgrade of the 4G network.⁴² Average fixed broadband speeds have likely exhibited growth over this period due to the rollout of the NBN, whose average maximum busy period download speeds measured three times higher than those for ADSL plans in 2018.⁴³

Price-based competition has in turn forced businesses to compete more intensely at the service level in a bid to deliver differentiated value propositions to customers. To achieve this, employers in the sector are placing emphasis on commercialisation skills, which blends technical skills with commercial skills to develop products and services that make peoples’ lives easier through technology. Employers are also increasing recognition enterprise skills, such as teamwork, communication and problem-solving, which enable workers from differing technical background to collaborate effectively.

Increased competition is driving revenue diversification and service differentiation

Mobile virtual network operators (MVNO) and over the top (OTT) providers have further challenged the traditional telco business model. While these entrants have likely contributed to increased price-based competition, they have also opened opportunities for revenue diversification and service differentiation among telcos.

MVNOs do not own wireless network infrastructure, but provide wireless services by obtaining bulk access to network services from mobile network operators (MNO), such as Telstra, Optus and Vodafone in Australia. These MVNOs, including Amaysim, TPG and Dodo, are then able to sell mobile and broadband services their customers at retail prices. The MVNO consumer base has grown from 1.2 million subscribers in 2010 to 3.2 million in 2017 (or 10 per cent of the Australian subscriber market).⁴⁴ Given their appeal to price-sensitive consumers, strong growth is further anticipated from MVNOs, as the budget segment of the subscriber market is expected to grow from 22 per cent in 2017

to 33 per cent in 2020.⁴⁵ As MVNO growth continues, industry suggests that skills demand will likely sway towards software-related skills, such as in enterprise networking and cloud computing, given that MVNO's telecoms infrastructure needs will be serviced at the wholesale level.

OTT providers bypass carrier networks by delivering media over the internet, such as video content (e.g., Netflix and Stan) and messaging and voice over Internet Protocol (VoIP) services (e.g., Skype, WeChat and Facebook's Messenger and WhatsApp). Messaging and VoIP services have become widely popular among consumers due as they offer increased functionality and typically do not require service fees. This has likely contributed to the prevalence of 'unlimited talk and text' plans to compete with OTT messaging and VoIP services.⁴⁶ While OTT providers have challenged traditional business models, they have also enabled partnership opportunities that allow telcos to diversify revenue stream and differentiate service offerings. For example, Optus offers post-paid mobile plans that allow users to stream popular services such as Netflix, Stan and Spotify outside of their data allowances.⁴⁷ As demand for OTT content increases, so too, industry suggests, will demand for commercialisation skills to better harness existing technology capabilities and infrastructure to deliver differentiated products and services to customers.

3.1.4 Impact of the NBN

Since its inception in 2009, the NBN has had significant impact on Australian households, businesses and the economy. In 2017, it is estimated that the NBN helped drive an additional \$1.2 billion in economic activity through facilitating the creation of new jobs and businesses and improving productivity.⁴⁸ In the ICT sector, the NBN has significantly shaped the competition and employment landscapes and will likely continue to do so as the rollout evolves.

Telecoms infrastructure work is more concentrated towards the NBN

As the monopoly wholesale broadband provider, NBN Co Limited has fundamentally changed the nature of competition in telecoms. By requiring Telstra and Optus to progressively disconnect certain legacy services that fell within its fixed line network footprint, the NBN aims to increase competition at the retail level – such as through lower prices and improved services – as opposed to the infrastructure level where incumbents such as Telstra and Optus have a scale advantage.⁴⁹ Indeed, monopolising wholesale broadband under NBN has likely contributed to increased price-based competition and the rise of MVNOs (as detailed above above). Indeed, the impact of the NBN has been cited by Telstra CEO Andrew Penn as a key reason for significant earnings loss at Telstra and its decision to reduce its workforce by 8,000 job roles over the next few years.⁵⁰ Industry indicates that NBN's is responsible for absorbing a significant proportion of field operations labour supply, whether as direct employees or contractors. This suggests that ICT workers with field operations job roles and skills are more concentrated towards the monopoly wholesale provider, and thus less widespread among retail providers including Telstra and Optus. This, in turn, implies that the NBN exercises significantly more influence over the nature and magnitude of demand for field operations job roles and skills than before.

NBN's construction phase is winding down

In 2017, it is estimated that the NBN helped to create an additional 2,900 jobs in Australia.⁵¹ This figure is anticipated to grow to 31,000 by 2021, once rollout has ended.⁵² As this date approaches, NBN's operating model – along with the job roles and skills of employees and contractors working for NBN – will invariably change. Given significant the challenges with the construction and performance of the NBN,⁵³ including ongoing consumer dissatisfaction,⁵⁴ industry expects there will be ongoing demand for maintenance and repair work beyond 2021. It is therefore anticipated that job roles and skills demand will broadly transition from installation and commission skills to maintenance, operations and diagnostics skills. Software-related skills across automated testing, data analytics and remote diagnostics have been noted as especially important due the immense scale of NBN's operations. However, if not effectively provisioned for, there is potential for oversupply of field operations job roles, such as cablers and installers, if they are unable to be appropriately upskilled or reskilled as commission work begins to decline.

3.2 Proposed responses

PwC's Skills for Australia works in an ongoing manner to ensure that training products contained in the ICT Training Package are fit for purpose and that workers in the ICT sector have the skills required

to adapt to these key drivers of change. Alongside the responses already underway (set out in Section 5), this document proposes responses for the training products that are not yet adapted to these trends.

In particular, this document sets out the proposed response to changing technology, cyber security, evolving telecoms business models, and the impact of the NBN affecting Telecommunications Technical Specialists and Telecommunications Engineering Professionals.

The consultation undertaken for the formulation of proposed responses is shown in Section 4 and the details for each project are set out in Section 6.

4 *Consultation undertaken*

Approach to consultation for proposed responses

Consultations undertaken to develop the 2019-20 Proposed Schedule of Work include views from 32 stakeholders across industry, peak bodies, registered training organisations (RTO), employee associations and other relevant organisations. Stakeholders have been consulted in person, via telephone interviews and through focus groups.

Please see Appendix C for a list of stakeholders consulted during the development of the 2019-20 proposed project, including spread across states and territories and stakeholder type.

Key issues and sensitivities from consultation

'Industry' opinions in the project details in Section 6 refer to views raised and validated in consultations outlined above. It is acknowledged that additional consultation will be conducted in future project work to confirm that these opinions are largely agreed upon by a broader group of stakeholders and to determine specific changes required in the Training Package.



Proposed Schedule of Work

5 Proposed schedule of work overview

PwC's Skills for Australia works in an ongoing manner to ensure training products contained in the ICT Training Package are fit for purpose and that workers in the ICT sector have the skills required to adapt to these key drivers for change. The previous project undertaken by the ICT IRC was:

- **Project 1E: Review of IT qualifications not fit for purpose**, which reviewed the suitability of IT qualifications that were deemed to be potentially not fit for purpose within the ICT Training Package and determined what changes or additions could be made to better meet industry needs.

The currently ongoing projects are:

- **Project 1F: Review of telecommunications technology qualifications not fit for purpose**, which reviews the suitability of a number of qualifications that may not be fit for purpose for industry, within the ICT Training Package, and determines what changes or additions can be made to better meet industry needs
- **Project 2: Getting a job in IT**, which reviews the units of competency (UoC) in three qualifications – Certificate I, Certificate II, and Certificate III in Information, Digital Media and Technology
- **Project 3: Getting a more specialised job in IT**, which reviews the UoCs in 14 Diplomas and Advanced Diplomas in IT and digital media.

Given the scope of this recent and ongoing work, the proposed schedule of work for the next four years only has a proposed project for 2019-20 (shown below). It is important that both registered training organisations and employers have time to understand and implement the changes made in this ongoing work before any future projects are scheduled. It is also important to note that for projects across the four years 2016-17 to 2019-20, all units of competency in the ICT Training Package will have been reviewed, either through a project (where they are added, edited or removed) or in assessing if they are relevant for a project (and were found to not require editing or deletion).

However, it is also acknowledged that training products need to be adaptable and flexible. Therefore, if any significant but unforeseen technological, regulatory or other changes impact the sector, additional projects may be proposed out of cycle as needed, or, depending on urgency, within the cases for change for 2020-21 and onwards.

2019-20	Project 4: Getting a more specialised job in telecommunications Addressing new and emerging skills needs for Telecommunications Technical Specialists and Telecommunications Engineering Professionals.
----------------	---

6 2019-20 Project details

This section serves as the case for change for Project 4: Getting a more specialised job in telecommunications. It outlines the project rationale, how Ministers' priorities are addressed, and the proposed consultation plan and scope.

6.1 Project 4: Getting a more specialised job in telecommunications

This project addresses the impact of changing technology in the convergence of IT and telecoms job roles and skills and pressure to upskill and reskill as the industry evolves affecting Telecommunications Technical Specialists and Telecommunications Engineering Professionals. Its proposed scope includes amalgamating 2 qualifications, updating 94 UoCs, creating 3 skill sets and 5 UoCs and assessing to delete 3 qualifications and 9 UoCs.

6.1.1 Rationale

Job roles affected

The project focuses on two key job role groups in the telecoms sector:

- **Telecommunications Technical Specialists** (including Radiocommunications Technicians; Telecommunications Field Engineers; Telecommunications Network Planners; Telecommunications Technical Officers or Technologists), who develop, monitor and support telecommunications networks and install computer equipment, computer systems and communication systems including microwave, telemetry, multiplexing, satellite, and radio and electromagnetic wave communication systems.⁵⁵ Industry consultation suggests these workers are typically the most senior technical people in the field for a particular area of communications, such as radio frequency or IP networking. In 2018, there were approximately 4,000 Telecommunications Technical Specialist job roles in Australia, which is forecast to grow 5 per cent by 2023.⁵⁶
- **Telecommunications Engineering Professionals** (including Telecommunications Engineers; Telecommunications Network Engineers), who design, construct, install, service and support telecommunications equipment, systems and facilities.⁵⁷ Industry consultation suggests that these workers tend not to specialise in a particular field, but work across a mix of telecoms systems, equipment and facilities at a holistic level to determine how various technologies can meet communications requirements. In 2018, there were approximately 15,500 Telecommunications Engineering Professional job roles, which is forecast to grow 20 per cent by 2023.⁵⁸

Drivers for change

Based on industry consultation to date, in five years' time these two job role groups will likely be very different from what they are today. There are three main drivers of this change:

1. **Changing technology, cyber threats and evolving telecoms business models are seeing IT and telecoms jobs roles and skills converge.** Telcos are responding to intense service and price competition and cyber security threats by investing heavily in advanced software and data capabilities, including big data analytics, software-defined networking (SDN), network function virtualisation (NFV) and AI. This is seeing software and data capabilities converge with conventional telecoms infrastructure capabilities, such as in routing, switching and network security. Already, convergence between IT and telecoms is enabling telcos to better understand their customers' needs, optimise the efficacy and efficiency of infrastructure and secure networks from cyber threats. Moreover, industry only expects software and data capabilities to become more critical in years to come as emerging technologies such as AI and IoT reach scale. To achieve this, industry is not only demanding more IT-related job roles – such as software engineers, data scientists and cyber security specialists – but also new software and data skills for Telecommunications Technical Specialists and Telecommunications Engineering Professionals. Namely, these skills include remotely analysing network infrastructure issues and diagnosing

solutions using big data; planning, designing and implementing enterprise networking solutions using an optimal mix of current and emerging technologies; and integrating cyber security and big data management best practices when working across telecoms equipment, systems and facilities.

2. **Changing technology and evolving telecoms business models are requiring workers to upskill and reskill.** Fierce industry competition, evolving business models and rapid technological change mean workers will likely need to upskill and reskill to retain employment as the sector evolves. A 2019 survey of CEOs globally revealed that telecoms CEOs are more concerned about the impact of technological change, compared to CEOs in other sectors; half of which believe technology could completely reshape the sector over the next five years (compared to a quarter of CEOs in other sectors).⁵⁹ Telstra’s recent decision to restructure a significant share of its workforce is a clear example of this, which will require many workers to upskill and reskill to remain employed by the telco.⁶⁰ Moreover, it is likely that workforce restructuring will occur for employees of, and contractors to, the NBN, as rollout reaches completion.⁶¹ Many stakeholders have added to this, highlighting the difficulty of ensuring that new and existing employees have the skills to withstand the evolving needs of the sector. For example, in addition to new software and data skills Telecommunications Technical Specialists and Telecommunications Engineering Professionals will require broader technical and enterprise skills that enable them to work with various types of new and emerging technologies across different types of organisations.
3. **Changing technology and evolving telecoms business models are increasing recognition of enterprise and commercial skills across all job roles.** In response to intense service and price competition – and new technologies replacing many physical, manual and basic cognitive tasks – telcos are demanding workers with enterprise and commercial skills who can disrupt old ways of working and readily adapt to fast-evolving business and technology needs. Industry emphasises that enterprise skills are essential and highly complementary to the technical nature of highly specialised Telecommunications Technical Specialists and Telecommunications Engineering Professionals job roles. For example, a worker possessing advanced technical knowledge and skills is of greater value if they also communicate effectively, work in a team, and demonstrate leadership. Moreover, for telcos to differentiate on customer experience and create valuable products and services, strong commercial skills are required from these job roles, such as defining business and technical problems and prototyping and testing solutions with customers’ needs front of mind.

Current training products

The ICT Training Package currently houses seven qualifications that provide skills for Telecommunications Technical Specialists and Telecommunication Engineering Professionals, ranging from Diploma through to Graduate Diploma (Table 3 below). Based on stakeholder consultation, it is understood that these qualifications have not been materially updated since 2008, with updates made in 2015 relating solely to Australian Skills Quality Authority (ASQA)/Australian Quality Training Framework (AQTF) compliance requirements set out in 2012.

Table 3: Qualifications in scope for Project 4

AQF level	Qualification
5	ICT51015 Diploma of Telecommunications Engineering
	ICT51115 Diploma of Telecommunications Planning and Design
6	ICT60615 Advanced Diploma of Telecommunications Network Engineering
	ICT80315 Graduate Certificate in Telecommunications
8	ICT80615 Graduate Certificate in Telecommunications Network Engineering
	ICT80515 Graduate Diploma of Telecommunications and Strategic Management
	ICT80415 Graduate Diploma of Telecommunications Network Engineering

In 2017, there were under 200 learners enrolled across these qualifications, mostly in ICT51015 Diploma of Telecommunications Engineering and ICT60615 Advanced Diploma of Telecommunications Network Engineering.⁶² Stakeholders indicate that this is in line with the niche job roles of Telecommunications Technical Specialists and Telecommunication Engineering Professionals that fundamentally more specialised, together representing approximately 4 per cent of all occupation in the ICT sector.⁶³ In particular, many the AQF level 8 qualifications were designed

with industry to support the professional development of highly specialised technical staff into senior technical and management jobs, which in turn lends itself to smaller learner cohorts.

Some stakeholders indicate that enrolments may also reflect use of alternative training for Telecommunications Technical Specialist and Telecommunication Engineering Professional job roles and that progression to these roles is largely a function of experience and on-the-job training. However, stakeholders also note that the quality and availability of on-the-job training is not consistent across the sector and larger businesses, in general, have greater capacity to supply appropriate formal and informal training, relative to smaller businesses. This in turn leads to inequality of access to training for workers seeking to upskill and reskill into more senior telecoms job roles.

Stakeholders emphasise that current training products in the ICT Training Package are not fit for purpose due to the age of the content and the qualifications' restrictive and dated design. That is, many of the qualifications are specifically designed to provide the skills and knowledge for Telecommunications Technical Specialists and Telecommunications Engineering Professionals job roles as they were over ten years ago. Many of the qualifications and UoCs focus on skills and knowledge related to conventional telecoms infrastructure and technology and have significant gaps in areas such as enterprise networking, data centres, big data and cloud computing. Moreover, many UoCs have been written to apply to specific technologies and protocols that existed at the time of writing, which has made it difficult for RTOs to sufficiently adapt these UoCs to address new technical and enterprise skills that industry requires. Furthermore, some qualification and UoCs were designed for job roles and skills that are no longer relevant to industry, such as ICT51115 Diploma of Telecommunications Planning and Design, which stakeholders indicate was specifically designed for a network planning and design job role that is now fulfilled offshore.

Demand for training product change

Stakeholder consultation strongly supports demand for training products to be refreshed to meet current and emerging technical and enterprise skills needs for Telecommunications Technical Specialists and Telecommunication Engineering Professionals. In their current form, the qualifications listed in Table 3 are not fit to address these skills as the content is significantly dated and the restrictive design largely prohibits RTOs from adapting this content to meets current and future skills needs as the sector evolves.

Therefore, three key changes to the qualifications are demanded by employers:

- **Updated technical and enterprise skills.** Fundamentally, stakeholders require qualifications and UoCs to be updated to provide the new technical and enterprise skills that Telecommunications Technical Specialists and Telecommunication Engineering Professionals require. Stakeholders indicate that many existing UoCs will likely need to be updated, created or reviewed for deletion to address the evolving role that software and data capabilities play across communications systems, equipment and facilities. In addition, UoCs will likely need to be updated or created to reflect industry demand for enterprise and commercial skills – including teamwork, empathy and business acumen – to receive further recognition in the way many skills are taught and assessed.
- **Simplification.** Employers require a rationalisation of qualifications at each AQF level in line with current and expected enrolments, particularly at AQF level 8 where there is a higher proportion of qualifications relative to enrolments. Stakeholders indicate that providing fewer qualifications at each AQF level will offer greater clarity to learners enrolling in, or employers hiring from, each qualification.
- **Flexibility.** For qualifications, an update of existing entry requirements and of packaging rules to ensure they are broad enough to accommodate the evolving nature of job roles (and are not restricted to job descriptions as they exist today) in the sector is required. For UoCs, the demand for flexibility requires that specifications in elements and performance criteria and associated assessment requirements are updated to be agnostic to specific technologies and protocols, such that training products can be easily adapted as technology and business needs evolve. Stakeholders suggest that greater utilisation of the implementation guide will also inform appropriate training and assessment requirements.

6.1.2 Ministers' priorities

The project aims to address three of the Ministers' priorities. Namely, to ensure that:

- **Obsolete and duplicate qualifications are removed from the system.** The project aims to identify, analyse – and in many instances delete – obsolete qualifications and UoCs to meet current and emerging skills needs. In particular, the project aims to rationalise qualifications at each AQF level and UoCs therein, in line with current and expected enrolments.
- **Foster greater recognition of skill sets.** The project aims to identify and analyse opportunities to develop skill sets and qualification streams relevant for relevant job roles. This, in turn, will provide greater clarity to learners and RTOs regarding the skills that industry requires for these job roles.
- **The training system better supports individuals to move more easily between related occupations.** The project aims to identify, analyse and update qualifications and UoCs to ensure they are broad and flexible enough to be adapted as job roles and skills evolve over time. Furthermore, the project aims to address industry demand for enterprise and cross sector skills that are applicable to job roles across multiple industries.

6.1.3 Consultation plan

PwC's Skills for Australia aims to consult with a variety of stakeholder organisations – large and small – in the telecoms sector, including but not limited to:

Employers	Industry associations, peak bodies and unions	Registered training organisations	Public/Government bodies
<ul style="list-style-type: none"> • ADLmobile • amaysim • Cisco • Ericsson • Huawei • NBN • Optus • Telstra • TPG (iiNet, Internode) • Vocus Group (iPrimus, Dodo Services) • Vodafone 	<ul style="list-style-type: none"> • Australian Digital and Telecommunications Industry Association • Australian Information Industry Association • Communications Alliance • Society of Cable Telecommunications Engineers 	<ul style="list-style-type: none"> • Private and enterprise RTOs • Technical and Further Education institutions 	<ul style="list-style-type: none"> • Australian Communications and Media Authority • Department of Communication and Arts

Given the emphasis of this project, organisations directly involved in the provision of telecommunications are expected to be the focus of consultation. However, noting that telecommunications underpin the operation of many ICT businesses and the convergence of software and telecommunications, consultation will also endeavour to include a broader range of stakeholders including software and internet based organisations.

Consultation will be undertaken in the form of one-to-one interviews and focus group consultations with key stakeholders. In addition, an industry survey will be developed and shared with PwC's Skills for Australia's ICT mailing list, and the networks of our IRC members more widely, to maximise the number of stakeholders who can contribute to the consultation process.

6.1.4 Scope of project

The project proposes to:

- **Assess for deletion 3 qualifications:** ICT51115 Diploma of Telecommunications Planning and Design, ICT80315 Graduate Certificate in Telecommunications and ICT80615 Graduate Certificate in Telecommunications Network Engineering

- **Amalgamate 2 qualifications:** ICT80515 Graduate Diploma of Telecommunications and Strategic Management and ICT80415 Graduate Diploma of Telecommunications Network Engineering
- **Update 2 qualifications:** ICT51015 Diploma of Telecommunications Engineering and ICT60615 Advanced Diploma of Telecommunications Network Engineering
- **Assess to delete 9 UoCs**, to appropriately reflect the current and emerging skills that industry requires
- **Update 94 UoCs**, to appropriately reflect the technical and enterprise skills that industry requires and remove references to specific technologies and protocols, such that they remain relevant as the nature of job roles and skills evolve over time
- **Create 3 skill sets**, to clearly define the skills required from learners for job roles related to IP networking, radio frequency networking and optical networking
- **Create, or import where appropriate, 5 UoCs** to address current and emerging skills, including integrating cyber security and big data management best practices when working across telecoms equipment, systems and facilities; and remotely analysing network infrastructure issues and diagnosing solutions using big data.

7 *IRC Sign off*

The Industry Skills Forecast and Proposed Schedule of Work was agreed to by:

A handwritten signature in black ink, appearing to read 'Jim Wyatt', with a large, stylized flourish at the end.

Jim Wyatt
Chair
Information and Communications Technology IRC

03/05/2019



Appendices

Appendix A Administrative Information

About PwC's Skills for Australia

PwC's Skills for Australia supports the Information and Communications Technology IRC. As a Skills Service Organisation (SSO), PwC's Skills for Australia is responsible for engaging with industry and working with our Industry Reference Committee to:

- Research what skills are needed in industries and businesses, both now and in the future, to provide the right skills to match job needs; helping us to stay at the forefront of global competitiveness and support continued economic prosperity.
- Identify and understand current and emerging trends in the global and domestic economies, and how they impact on Australia's skills needs.
- Revise vocational qualifications and training content to better match what people will learn with the skills needs of industries and businesses, giving workers the best possible chance of developing work ready skills.

About the Industry Reference Committee

The ICT IRC comprises 13 members, as set out in Table 4 below. The IRC has set the review and development agenda for the ICT Training Package over the coming four year period. The 2019 Industry Skills Forecast and Proposed Schedule of Work was reviewed and approved by the membership below in April 2019.

Table 4: ICT IRC membership

Name	Organisation	Role
Jim Wyatt	Optimi Digital	Chair
Alison Wall	nbn	Deputy Chair
Charles Hoang	Australian Industry Group	Member
David Smithwick	Communication Workers Union	Member
David Masters	Microsoft Australia	Member
Emma Broadbent	Cisco	Member
Emma McDonald	Telstra	Member
Kevin Harris	Australian Information Industry Association	Member
Louise Smith	Australian Computer Society	Member
Owen Pierce	Australian Cyber Security Growth Network (AustCyber)	Member
Patrick Emery	Australian Communications Media Authority (ACMA)	Member
Yvonne Web	Industry Skills Advisory Council Northern Territory	Member
TBC	Digital Transformation Agency	Member

Appendix B ICT Training Package profile

Table 5: Enrolments by qualification

Qualification	2017 Program Enrolments
Digital Media	
Certificate IV in Digital Media Technologies	305
Certificate IV in Digital and Interactive Games	595
Diploma of Digital and Interactive Games	2,700
Diploma of Digital Media Technologies	810
Information Technology	
Certificate I in Information, Digital Media and Technology	14,495
Certificate II in Information, Digital Media and Technology	12,775
Certificate II in National Broadband Network Construction	10
Certificate III in Broadband and Wireless Networks Technology	535
Certificate III in Information, Digital Media and Technology	15,895
Certificate III in Broadband and Wireless Networks	5
Certificate IV in Information Technology	2,915
Certificate IV in Information Technology Support	440
Certificate IV in Web-Based Technologies	1,390
Certificate IV in Information Technology Networking	2,730
Certificate IV in Programming	1,860
Certificate IV in Information Technology Testing	35
Certificate IV in Systems Analysis and Design	30
Certificate IV in Computer Systems Technology	455
Diploma of Information Technology	3,430
Diploma of Information Technology Systems Administration	315
Diploma of Information Technology Networking	3,630
Diploma of Database Design and Development	130
Diploma of Website Development	1,575
Diploma of Software Development	1,675
Diploma of Systems Analysis and Design	240
Advanced Diploma of Information Technology	870
Advanced Diploma of Network Security	410
Advanced Diploma of Information Technology Business Analysis	350
Advanced Diploma of Information Technology Project Management	310
Advanced Diploma of Computer Systems Technology	390
Graduate Certificate in Information Technology and Strategic Management	10
Graduate Certificate in Information Technology Sustainability	0
Telecommunication Technology	
Certificate II in Telecommunications Technology	360
Certificate II in Telecommunications	455
Certificate II in Telecommunications Network Build and Operate	510
Certificate II in Telecommunications Cabling	290

Certificate III in Telecommunications	2,990
Certificate III in Telecommunications Digital Reception Technology	10
Certificate III in Telecommunications Cabling	305
Certificate III in Telecommunications Network Build and Operate	700
Certificate III in Telecommunications Technology	2,770
Certificate IV in Telecommunications Network Engineering	130
Certificate IV in Telecommunications Networks Technology	15
Certificate IV in Telecommunications Engineering Technology	240
Diploma of Telecommunications Engineering	45
Diploma of Telecommunications Planning and Design	n/a
Advanced Diploma of Telecommunications Network Engineering	105
Graduate Diploma of Telecommunications Network Engineering	10
Graduate Diploma of Telecommunications and Strategic Management	15
Graduate Certificate in Telecommunications	n/a
Graduate Certificate in Telecommunications Network Engineering	15

Source: NCVET (2018) *Total VET Students and Courses 2017*

Note: n/a means the qualification is not included in the NCVET data set and enrolments are assumed to be zero.

Appendix C Stakeholder consultations

As summarised in Section 4, the consultation approach to developing this proposed schedule of work included individual consultations, group consultations, a public survey and written submissions. The stakeholders who were consulted during the development of the projects are detailed in *Table 6* below. Additionally, a draft version of this report was provided to all state and territory training authorities (STAs) and feedback was received and incorporated from STAs in Queensland, New South Wales and Victoria.

Although not explicitly called out as stakeholders consulted in the table below, this document and proposed project details has also relied on subject matter expertise gained from structured interviews, discussion in meetings and feedback on drafts of this document from members of the ICT IRC. These IRC members are from across jurisdictions and stakeholder types.

During our consultation process, attempts were made to cover all jurisdictions and stakeholder types. However, stakeholders were more readily available in regions where this training is currently delivered and where employment in the relevant sector is. Comparative size of the relevant sector is also a factor in the availability of stakeholders.

It is acknowledged that additional consultation will be conducted in future project work to continue to refine stakeholder opinions and to determine specific changes required to training products.

Table 6: List of stakeholders consulted during the development of the projects proposed for 2019-20

Organisation	Stakeholder type	State	Contact method
Australian Cyber Security Growth Network (AustCyber)	Industry	ACT	Focus group
Australian College of Information Technology	RTO	QLD	Interview
Australian Communications and Media Authority (ACMA)	Government	VIC	Focus group
Australian Computer Society	Industry association	NSW	Focus group
Australian Digital and Telecommunications Industry Association (ADTIA)	Industry association	VIC	Interview
Australian Digital and Telecommunications Industry Association (ADTIA)	Industry association	VIC	Interview
Australian Industry Group (AIG)	Industry association	NSW	Focus group
Australian Information Industry Association (AIIA)	Industry association	ACT	Focus group
BSA Limited	Industry	NSW	Interview
BSA Limited	Industry	NSW	Interview
Cisco	Industry	NSW	Focus group
ComTech (Ramsden Telecommunications Training)	RTO	VIC	Interview
Communications Workers Union (CWU)	Union	VIC	Focus group
Communications Workers Union (CWU)	Union	VIC	Interview
Downer Group	Industry	NSW	Interview
Huawei Australia	Industry	NSW	Interview
Industry Skills Advisory Council	Industry	NT	Focus group
Lendlease	Industry	NSW	Interview
Lendlease	Industry	NSW	Interview
Lendlease	Industry	NSW	Interview
Microsoft	Industry	ACT	Focus group
Milcom Institute	RTO	VIC	Interview
NBN	Industry	VIC	Focus group
Nine Network Australia	Industry	NSW	Interview

NIT Australia	RTO	WA	Interview
NIT Australia	RTO	WA	Interview
Optimi Digital	Industry	WA	Focus group
Optus	Industry	NSW	Interview
Optus	Industry	NSW	Interview
TAFE NSW	RTO	NSW	Interview
Telstra	Industry	VIC	Focus group
The Imperial College of Australia	RTO	VIC	Interview
Skills Tasmania	Government	TAS	Interview

-
- ¹ Department of Jobs and Small Business (2018) *2018 Occupational Projections – five years to May 2023*
- ² Department of Jobs and Small Business (2018) *2018 Occupational Projections – five years to May 2023*
- ³ National Centre for Vocational Education Research (NCVER) (2018) *Total VET students and enrolments 2017*
- ⁴ Hales, J. (2018) *Top 10 Certifications with Staying Power*, Global Knowledge
- ⁵ NCVER (2017) *Survey of employers’ use and views of the VET system 2017*
- ⁶ NCVER (2018) *VET Student Outcomes, 2018*
- ⁷ NCVER (2018) *VET Student Outcomes, 2018*
- ⁸ Global Knowledge Training (2018) *IT Skills and Salary Report: A Comprehensive Study from Global Knowledge*
- ⁹ Department of Jobs and Small Business (2018) *2018 Occupational Projections – five years to May 2023*
- ¹⁰ ABS (2009) *Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, cat. no. 1220.0*
- ¹¹ ABS (2009) *Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, cat. no. 1220.0*
- ¹² ABS (2009) *Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, cat. no. 1220.0*
- ¹³ Berman, A. and Dorrier, J. (2016) *Technology Feels Like It’s Accelerating – Because It Actually Is*, SingularityHub
- ¹⁴ McKinsey & Company (2019) *Australia’s automation opportunity*
- ¹⁵ McKinsey & Company (2019) *Australia’s automation opportunity*
- ¹⁶ McKinsey & Company (2019) *Australia’s automation opportunity*
- ¹⁷ McKinsey & Company (2019) *Australia’s automation opportunity*
- ¹⁸ McKinsey & Company (2019) *Australia’s automation opportunity*
- ¹⁹ Strategy& (part of the PwC network) (2019) *To build or not to build?*
- ²⁰ Strategy& (part of the PwC network) (2019) *To build or not to build?*
- ²¹ Strategy& (part of the PwC network) (2019) *To build or not to build?*
- ²² Strategy& (part of the PwC network) (2019) *To build or not to build?*
- ²³ Australian Computer Society, Strategy& (part of the PwC network) (2018) *Australia’s IoT Opportunity: Driving Future Growth*
- ²⁴ Strategy& (part of the PwC network) (2019) *To build or not to build?*
- ²⁵ PwC (2019) *PwC’s 22nd CEO Survey*
- ²⁶ Herbert Smith Freehills (2018) *Managing cyber security risks in the telecommunications sector*
- ²⁷ Telstra (2017) *Security Operations Centre*
- ²⁸ Singtel (2016) *Annual report 2016*
- ²⁹ Duke, J. (2018) *Optus buys cybersecurity firm Hivint for \$23m*, The Sydney Morning Herald
- ³⁰ Office of the Minister for Home Affairs (2018) *Telecommunications Sector Security Reforms come into force*
- ³¹ Slezak, M. and Bogle, A. (2018) *Huawei banned from 5G mobile infrastructure rollout in Australia*, Australian Broadcasting Corporation
- ³² Herbert Smith Freehills (2018) *Managing cyber security risks in the telecommunications sector*
- ³³ Herbert Smith Freehills (2018) *Managing cyber security risks in the telecommunications sector*
- ³⁴ Strategy& (part of the PwC network) (2019) *To build or not to build?*
- ³⁵ PwC (2019) *Five trends for Australian telecoms in 2019*
- ³⁶ ACCC (2018) *Competition and price changes in telecommunications services in Australia 2016-17*
- ³⁷ ACCC (2018) *Competition and price changes in telecommunications services in Australia 2016-17*
- ³⁸ ACCC (2018) *Competition and price changes in telecommunications services in Australia 2016-17*
- ³⁹ ACCC (2018) *Competition and price changes in telecommunications services in Australia 2016-17*
- ⁴⁰ ACCC (2018) *Competition and price changes in telecommunications services in Australia 2016-17*
- ⁴¹ ACCC (2018) *Competition and price changes in telecommunications services in Australia 2016-17*
- ⁴² Strategy& (part of the PwC network) (2019) *To build or not to build?*
- ⁴³ ACCC (2018) *NBN broadband speeds much improved for most, but not all*
- ⁴⁴ Venture Insights (2017) *Australian MVNOs are here to stay but...*
- ⁴⁵ Strategy& (part of the PwC network) (2019) *To build or not to build?*
- ⁴⁶ ACCC (2018) *Communication Sector Market Study*
- ⁴⁷ Optus (2019) *Music streaming*; Optus (2019) *Mobile TV streaming*
- ⁴⁸ NBN Co Limited, AlphaBeta (2018) *Connecting Australia Report*
- ⁴⁹ Morrow, B. (2018) *nbn – the challenges of transforming an industry*
- ⁵⁰ Fernyhough, J. (2019) *Andy Penn blames NBN for Telstra job cuts*, The Australian Financial Review
- ⁵¹ NBN Co Limited, AlphaBeta (2018) *Connecting Australia Report*
- ⁵² NBN Co Limited, AlphaBeta (2018) *Connecting Australia Report*
- ⁵³ Morrow, B. (2018) *nbn – the challenges of transforming an industry*

-
- ⁵⁴ ACCC (2018) *Competition and price changes in telecommunications services in Australia 2016-17*
- ⁵⁵ ABS (2016) *1220.0 - ANZSCO - Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, Unit Group 3132, Telecommunications Technical Specialists*
- ⁵⁶ ABS (2016) *1220.0 - ANZSCO - Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, Unit Group 2633, Telecommunications Engineering Professionals*
- ⁵⁷ ABS (2016) *1220.0 - ANZSCO - Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, Unit Group 2633, Telecommunications Engineering Professionals*
- ⁵⁸ Department of Jobs and Small Business (2018) *2018 Occupation Projections – five years to May 2023*
- ⁵⁹ Strategy& (part of the PwC network) (2019) *To build or not to build?*
- ⁶⁰ Fernyhough, J. (2019) *Andy Penn blames NBN for Telstra job cuts*, The Australian Financial Review
- ⁶¹ NBN Co Limited, AlphaBeta (2018) *Connecting Australia Report*
- ⁶² NCVER (2019) *TVA program enrolments 2014-2017*
- ⁶³ Department of Jobs and Small Business (2018) *2018 Occupational Projections – five years to May 2023*

© 2019 PricewaterhouseCoopers Data and Analytics Services Pty Limited. All rights reserved.

PwC refers to the Australia member firm, and may sometimes refer to the PwC network. Each member firm is a separate legal entity. Please see www.pwc.com/structure for further details.

This content is for general information purposes only, and should not be used as a substitute for consultation with professional advisors.

Liability limited by a scheme approved under Professional Standards Legislation.

At PwC Australia our purpose is to build trust in society and solve important problems. We're a network of firms in 158 countries with more than 236,000 people who are committed to delivering quality in assurance, advisory and tax services. Find out more and tell us what matters to you by visiting us at www.pwc.com.au.