THE NEXT TALENT WAVE:

NAVIGATING THE DIGITAL SHIFT – OUTLOOK 2021

ICTC CTIC
Information and Communications Technology Council
Conseil des technologies de l'information et des communications

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PREFACE

The Information and Communications Technology Council (ICTC) is a not-for-profit national centre of expertise for the digital economy. Through trusted research, innovative talent solutions, and practical policy advice, ICTC fosters innovative and globally competitive Canadian industries empowered by a talented and diverse digital workforce. The authors of this report made all reasonable efforts to ensure accuracy and fair reflection of the diverse perspectives gathered during their consultations. The opinions and interpretations in this publication are those of the authors and do not necessarily reflect those of the Government of Canada.

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FOREWORD

Every day we are bombarded with change. We see change fueled by shifts in workforce and population demographics, political and economic landscapes, as well as innovation in technology and business models. In many cases, change in one of these areas will result in change in another and vice versa, leading to a chain reaction of accelerated transformation with broad impact and implications.

Today, we readily accept trends such as sharing economies, digital currencies, and the globalization of markets as established concepts, when half a decade ago they were conversations we might have ascribed to futurists.

But the rapid march of progress doesn't stop there. Investors, educators, researchers, and business leaders are openly pursuing artificial intelligence as a near-term reality. As consumers, workers, and citizens, we are surrounded by visible and invisible examples of this science fiction reality. We drive semi-autonomous vehicles and marvel at how practical they are, while nobody seems to doubt the impending arrival of fully autonomous private and commercial transportation. We interact with service bots and often don't even know we are communicating with a machine. We drink milk from cows that are fed, milked, and bottled by robots, accomplished without the need for as many human workers as in the past.

We benefit from reduced costs and improved accessibility to everyday articles assembled and packaged by robots, and soon to be shipped to our front doors by drones. We invest in stock markets alongside computer algorithms that make trade decisions and investments in nanoseconds without the aid of the highly skilled investment advisors we used to rely on.

These advancements are part of what some call the fourth industrial revolution. The balanced view of this progress is that it results in measurable economic productivity improvements. On the other hand, this evolution has resulted in a measurable reduction of employment across all sectors of labour, impacting both low- and high-skilled workers.

Previous industrial revolutions were marked by a net positive change. For example, the loss of jobs due to productivity gains were mostly offset by new and improved employment opportunities for displaced workers, leading to an overall uplift in working conditions and standards of living. But the pace of change we see today is raising a new question.

Can the system rebalance itself fast enough to create new employment opportunities for workers displaced by automation?

As leaders across government, education and business, we are all scrambling to understand and respond to the impacts of these changes, and many of us are feeling a little overwhelmed and a little unsure of how to proceed.

It is not easy to anticipate the future, but we can and should rely on basic principles when we plan for it. The pace of our responses must match the pace of change we measure in our environment. We must plan for the certain knowledge that the rate of change will continue to increase. We must accept that multi-year policy responses will not adequately protect a future impacted by macro-changes that evolve within months. We must accept that the ownership for those responses doesn't start and end with government. It is a responsibility shared by business and education alike, to provide policies, investment, strategic focus and appropriate skills development.

> "Together, we have the expertise to help redefine and empower a talented and diverse digital workforce."

The Information and Communications and Technology Council (ICTC) and its partners are at the forefront of this new future. Together, we have the expertise to help redefine and empower a talented and diverse digital workforce.

Canada has a long history of innovation, economic growth, and leadership with respect to equality and social standards. As a proud Canadian innovator, Kinaxis® is committed to working with ICTC and other partners to identify trends, develop solutions, and help grow Canada's position as an economic power, a social leader and home of an evolved workforce.

Jack Noppé

Chief Technology Officer, Kinaxis

EXECUTIVE SUMMARY

Today, digital transformation continues to radically change the face of business in Canada. The advent of the collaborative economy, the rise of artificial intelligence (AI), the adoption of blockchain in financial services, and advances in autonomous cars are all but a manifestation of the innovative nature of this digital landscape.

Digital disruption is being felt in the banking, media, transportation, manufacturing, health, retail, and many other sectors. This reshaping of traditional markets is also challenging every aspect of incumbent firms in an increasingly global and competitive landscape. This is evidenced by the advent of the sharing economy and other unfettered innovations that are increasingly being empowered by everyday entrepreneurs. The accelerated wave of business transformation, however, comes against a backdrop of powerful technological, economic, privacy, security and environmental global trends that are all contributing to a new realm of economic prospects. Aging demographics, disproportionate representation, immigration trends and many other social factors are also contributing to a changing social paradigm.

The hallmark of success in this environment is equipping Canadians with the relevant technology skills to innovate, adopt technologies, and produce higher-value goods and services. This will empower a more dynamic economy based on our ability as a nation to intensify investments in infrastructure and R&D, diversify our industries, and expand trade. The recent 2017 federal budget announcement laid a strong foundation for success in this environment.

During the period 2011 to 2016, the Canadian digital economy experienced a steady labour growth of around 2.38%, compared to that of 1.17% for the rest of the economy. The overall digital labour force now amounts to around 1,389,000 professionals, and is reflective of the health of this economy and the expanding range of occupations in this space.

The competition and lead-time to staff critical positions, however, remain a challenge for many businesses in Canada and especially for Small and Medium-Sized Enterprises (SMEs). ICTC's (Labour Market Outlook 2017-2021) highlights an acute digital talent demand of around 216,000 by 2021. Addressing this challenge with particular focus on youth will be an important priority for the next number of years.

INTRODUCTION: CANADIAN DIGITAL ECONOMY AT A GLANCE

The expansionary policy stance in the recent 2017 federal budget in investments in digital skills development and business scale up, among many others, are expected to further fuel the Canadian economy in the next number of years despite potential signs of rising interest rates. While the contractionary cycle in the resources sector slows, the rest of the Canadian economy is seeing strength aided by a lower Canadian dollar and rising exports.

Global economic activities are also expected to pick up in 2017 and onwards. The International Monetary Fund (IMF)'s latest economic outlook predicts that global output growth will increase 3% in 2017 and 3.6% in 2018.[1] Economic growth in Canada is predicted to have an average growth rate of 2%[2] from 2017 to 2018, while the United States, Canada's largest trading partner, has a projected growth rate of 2.4%. In the coming two years, we can expect Canadian industries to benefit from increasing demand for our merchandise and services.

Canada's economy continues to grow because we value free trade agreements (FTAs) that help us bring our products to market. International trade activities significantly boost our economy. Taken together, the value of exports and imports is 65% of our gross domestic product (GDP).[3] Our FTAs have played a significant role in increasing trade activities with other countries, increasing labour mobility and strengthening domestic economic growth. Besides 12 in-force FTAs and three signed FTAs, we have also initiated exploratory FTA discussions with five countries—including China, which is the world's second largest economy and Canada's second largest single-country trading partner.

In 2017, Canada and the European Union (EU) will implement one of our most progressive FTAs to date, the Comprehensive Economic and Trade Agreement (CETA). When CETA comes into force, the EU will remove tariffs on 98% of its tariff lines.[4] In return, Canadian producers, manufacturers and exporters will find their services and products in a much more competitive market position. CETA's temporary entry provisions will also increase the mobility of highly skilled technical workers, investors, C-level executives and intra-company transferees, which increases competition for Canadian companies to secure and retain talent.

According to Export Development Canada (EDC), Canada's total goods exports and services sector will grow 3% and 5%, respectively, in 2017.[5] At the same time, Industrial machinery and equipment is projected to grow 4%, advanced technology by 1% and aircraft and parts by 7%.[6] This translates into an increasing demand for Canadian merchandise and services across all sectors, along with a need to expand our digitals labour and market to leverage the full potential of several transformational technologies that are expected to reshape the competitive advantage of Canada's economy in a global market.

The first part of this report discusses the five key transformational technologies that will drive an increasing demand for digital talent. The second part of this report presents an employment-trend analysis for Canada's digital economy from 2009 to 2016. The third part provides labour market forecasting analyses for the next 5 years at the national and provincial levels, and reviews the information and communications technology (ICT) occupations that are currently most in demand. The final section offers recommendations for how policymakers, educators and industry leaders can collaborate to address the digital talent scarcity prevailing in Canada's digital economy.

1 World Economic Outlook Update, IMF: http://www.imf.org/external/pubs/ft/weo/2017/update/01/index.html

2 World Economic Outlook Update, IMF: http://www.imf.org/external/pubs/ft/weo/2017/update/01/index.html

3 2017 Index of Economic Freedom: http://www.heritage.org/index/country/canada

4 CETA Agreement Overview: http://www.international.gc.ca/trade-commerce/trade-agreements-accords-commerciaux/agr-acc/ceta-aecg/overview-apercu.aspx?lang=eng

5 The Great Hesitation: Global Export Forecast, p. 19: http://www.edc.ca/EN/Knowledge-Centre/Economic-Analysis-and-Research/Documents/gef-fall-2016.pdf

6 The Great Hesitation: Global Export Forecast, p. 19: http://www.edc.ca/EN/Knowledge-Centre/Economic-Analysis-and-Research/Documents/gef-fall-2016.pdf

FIVE KEY TRANSFORMATIONAL TECHNOLOGIES

While social, mobile, apps, analytics and cloud (SMAAC) technologies under the larger umbrella of the Internet of Things (IoT) continue to reshape the Canadian economy, they do not stand alone. In the next several years, the following five key technologies will have the highest demand for skilled workers in the digital economy: virtual reality (VR) and augmented reality (AR), fifth generation (5G) mobile technology, three-dimensional (3D) printing, blockchain and artificial intelligence (AI). All sectors of the economy are integrating these technologies in an effort to increase productivity and efficiency, reduce costs, generate revenues, and heighten innovation and growth.

VIRTUAL AND AUGMENTED REALITY

Virtual reality (VR), also called artificial reality or computer-simulated reality, creates for users a realistic and immersive environment by generating realistic images, sounds and other sensations, using interactive hardware and software. Augmented reality (AR), which belongs to a general concept of computer-mediated reality, enhances or supplements a viewers' real world with computer-generated information, such as audio, video, pictures, etc. While VR puts users inside the virtual world by creating a fully immersive and closed simulated environment, augmented reality puts virtual elements into a user's real world on their smartphones, tablets and other applications.

"According to the new Worldwide Semiannual Augmented and Virtual Reality Spending Guide from the International Data Corporation (IDC), worldwide revenues for the augmented reality and virtual reality (AR/VR) market will grow from $5.2 billion in 2016 to more than $162 billion in 2020. This represents a compound annual growth rate (CAGR) of 181.3% over the 2015-2020 forecast period."Goldman Sachs Research is convinced that both VR and AR have the potential to be as game-changing as the advent of the PC."

> "We think [virtual and augmented reality] has the potential to transform how we interact with almost every industry today, and we think it will be equally transformative both from a consumer and an enterprise perspective."
>
> —HEATHER BELLINI, GOLDMAN SACHS RESEARCH

7 Worldwide Revenues for Augmented and Virtual Reality Forecast to Reach $162 Billion in 2020, According to IDC," IDC, Aug.15, 2016: http://www.idc.com/getdoc.jsp?containerId=prUS41676216

8 "Virtual and augmented reality may be a 'game changer' like PCs, says Goldman," Tech Trader Daily, Jan. 13, 2016: http://blogs.barrons.com/techtraderdaily/2016/01/13/virtual-and-augmented-reality-may-be-a-game-changer-like-pcs-says-goldman/

5G MOBILE

5G mobile technology is a catalyst for transformative change across multiple industries. Its ubiquity, low latency and adaptability support a range of sectors (e.g., autonomous vehicle manufacturing, industrial automation, health care, education, public infrastructure). It allows for efficient handling of a large number of devices, including smart objects in the IoT, which support accessible connections. The global 5G value chain will generate $3.5 trillion in output, outweighing the current value of today's entire mobile value chain, and will support 22 million jobs in 2035.[9] Its improved capacity to handle a significantly greater number of devices and more efficient data transmission will be able to support applications that require high reliability and ultra-low latency connectivity.

Canada's major telecom operators are taking early steps toward this leap in wireless technology. Bell, Rogers and Telus are all participating in a global effort to develop operating standards for 5G wireless networks, with Bell, the nation's largest telecommunications company, set to begin testing the emerging architecture.[10] This will translate to an upsurge in demand for ICT professionals with the specialized technical skills able to install, manage, and scale-up this technology.

3D PRINTING[11]

Additive manufacturing (AM), also known as 3D Printing, is a technology and process that makes a physical object by laying down many thin layers of a material in succession, according to a 3D digital model. It has great potential to shift production and distribution from our current model to an on-demand, on-site, customized production model.[12] McKinsey estimates that 3D printing could generate an economic impact of $230 to $550 billion per year by 2025, based on reduced costs and the value of customization.[13]

The adoption of 3D printing by businesses will produce various economic benefits: employment opportunities, lower production costs and improved production efficiency, which will allow employers to further invest in research and development and create more new and higher-skilled jobs. Scott Paul, President of the Alliance for American Manufacturing, gives the example of a small tool-and-die casting company whose costs start falling as their upfront investment in a 3D printing pays off, allowing them to take on larger-scale jobs that require more complexity.[14]

To realize the economic potential of this technology, industries such as manufacturing, technical services and trade will not only have a strong demand for ICT talent, but also digitally skilled talent in 'non-traditional' tech roles.

9 HIS Economics and HIS Technology: The 5G Economy.

10 "Canada's major telecoms set to leap in to 5G technology," Toronto Star, May 22, 2016: https://www.thestar.com/business/2016/05/22/canadas-major-telecoms-set-to-leap-in-to-5g-technology.html

11 ICTC's study on Additive Manufacturing will be published in May 2017.

12 3D Printing Industry: https://3dprintingindustry.com/

13 "3-D printing takes shape," McKinsey Quarterly, January 2014: http://www.mckinsey.com/business-functions/operations/our-insights/3-d-printing-takes-shape

14 "This technology could have the biggest impact on American jobs since offspring," Business Insider, Sept. 4, 2014: http://www.businessinsider.com/how-3d-printing-will-affect-manufacturing-jobs-2014-8

BLOCKCHAIN

With the emergence of the cryptocurrencies like Bitcoin, increased attention is now being given to the technology behind them: blockchain. The essence of blockchain technology is a distributed ledger method that "chains" together all the transactions among a large group of unrelated companies. Blockchain allows unrelated computers and companies to simultaneously collect and store information without relying on any trusted central authority. The technology is viewed as being harder to corrupt or hack because of its reliance on many participants rather than a single authority.

Blockchain has already started to change the financial services industry. Royal Bank of Canada has joined the R3CEV Consortium to develop a blockchain infrastructure for banking. As well, Microsoft, JP Morgan Chase and other leading technology companies are joining forces to create a new computing system based on the virtual currency network Ethereum. According to Accenture PLC, blockchain could save the 10 largest banks $8 to $12 billion a year in infrastructure costs—or 30% of their total costs in that area.[15]

The application of blockchain technology is not limited to the financial sector. Walmart, the $214-billion retail giant, has begun to utilize IBM's blockchain-based systems to identify and remove recalled foods from its product lists.[16] With sectors like financial services, retail and energy further developing blockchain infrastructure, ICT professionals will certainly be in high demand to work with this technology.

ARTIFICIAL INTELLIGENCE (AI)

AI in not a field in and of itself; rather it is "a heterogeneous mixture of research fields."[17] In computer science, AI research defines itself as the study of intelligent agents: any device that perceives its environment and takes actions that maximize its chance of success at some goal.[18]

Although AI is still in the early stages of development, its global economic impact is expected to reach between $7.1 to $13.1 trillion by 2025.[19] AI has already been used to develop and advance numerous fields and industries, including autonomous transportation, banking services, manufacturing, retail, robotics, health informatics, bioinformatics, e-commerce and more. For instance, in early 2017, Ford Motor announced its plans to invest $1 billion over the next five years in an AI start-up. Company executives have indicated that mobility services could generate returns of around 20%, compared with the 8% Ford earns on its vehicles today.[20]

15 "Business giants to announce creation of a computing system based on Ethereum," New York Times, Feb. 27, 2017: https://www.nytimes.com/2017/02/27/business/dealbook/ethereum-alliance-business-banking-security.html?_r=0

16 "Walmart experiments with blockchain to safely store food," The Cointelegraph, Nov. 22, 2016: https://cointelegraph.com/news/walmart-experiments-with-blockchain-to-safely-store-food

17 Artificial Intelligence in Canada: Where Do We Stand?, ICTC, April 2015: http://www.ictc-ctic.ca/wp-content/uploads/2015/06/AI-White-paper-final-English1.pdf

18 Russell & Norvig (2003).

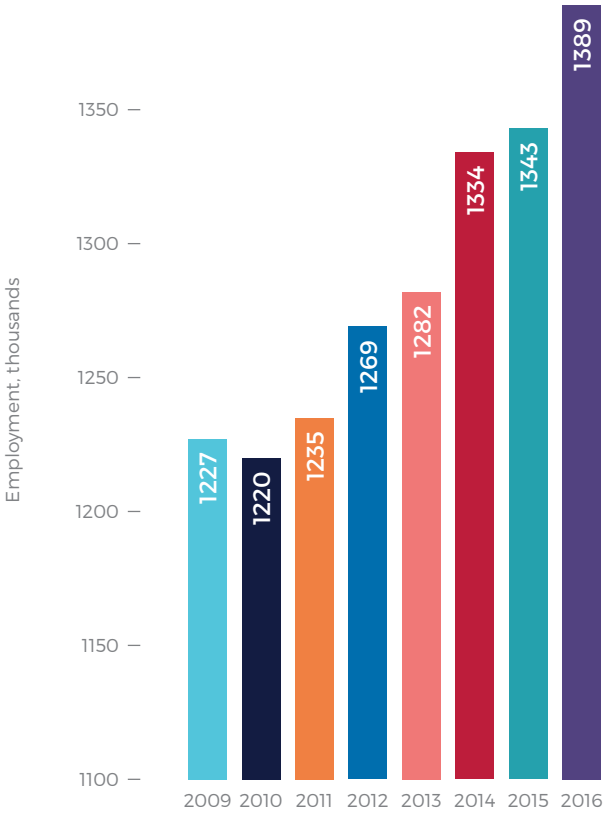
19 "Disruptive technologies: Advances that will transform life, business, and the global economy," McKinsey Global Institute Report, May 2013: http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies

20 "Ford to invest $1 billion in artificial intelligence start-up," New York Times, Feb. 10, 2017: https://www.nytimes.com/2017/02/10/technology/ford-invests-billion-artificial-intelligence.html?_r=0

THE STATE OF CANADA'S CURRENT ICT WORKFORCE

Driven by the rapidly expanding ICT industry and an increasing demand for ICT talent across all industries, employment in the Canadian digital economy experienced steady growth from 2009 to 2016. As shown in Figure 2, its growth rate for the 5 years between 2011 and 2016 was 2.38%, compared with that of 1.17% across all other Canadian industries.

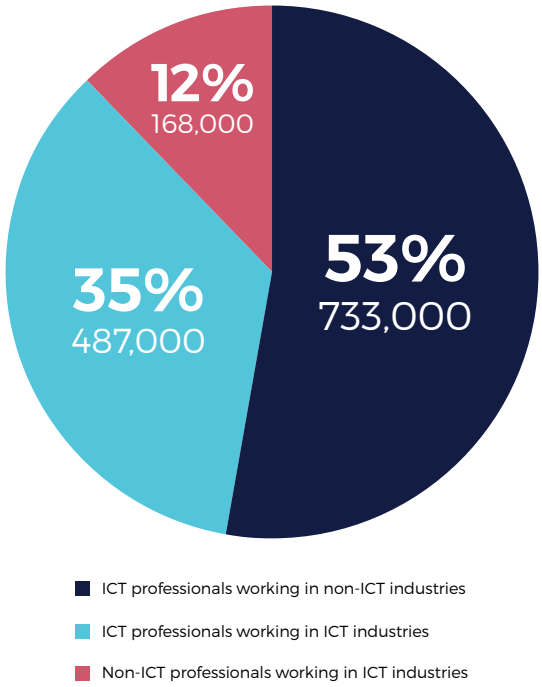
Figure 1:
Canada's digital economy, 2009–2016



Source:
ICTC, Statistics Canada Labour Force Survey, monthly averages, 2009–2016

In 2016, there were approximately 1,389,000 professionals working in the Canadian digital economy. This figure includes 487,000 ICT professionals working in the ICT industry, 733,000 ICT professionals working in non-ICT industries and approximately 168,000 non-ICT professionals working in the ICT industry.

Figure 2:
Employment segmentation in the digital economy, 2016

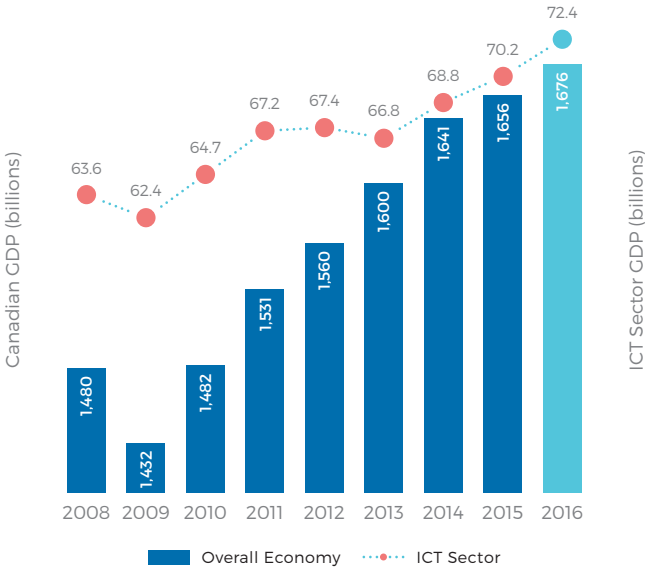


Source:
ICTC, Statistics Canada Labour Force Survey, monthly averages, 2009–2016

CANADA'S ICT SECTOR IS GROWING

The ICT sector accounted for 4.3% of Canada's total output of $1,676 billion as of 2016, with ICT services contributing 95% to the total Canadian ICT sector's real gross domestic product (GDP). Between 2015 and 2016, the impact of the ICT sector on Canada's GDP increased by nearly $2.12 billion to $72.4 billion total.

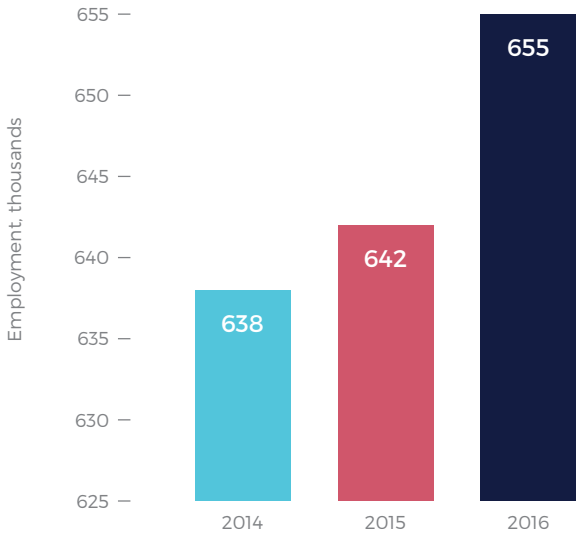
Figure 3:
Canadian and ICT sector gross domestic product, 2008–2016



Source:
ICTC, Statistics Canada, 2016

Employment of ICT professionals and non-ICT professionals working in the industry has also experienced steady growth. Figure 4 shows the trend of workers joining the ICT industry from 2014 to 2016. Between 2015 and 2016, there were 13,000 new jobs created in Canada's ICT industry.

Figure 4:
ICT industry employment, 2014–2016



Source:
ICTC, Statistics Canada Labour Force Survey, monthly averages, 2014–2016

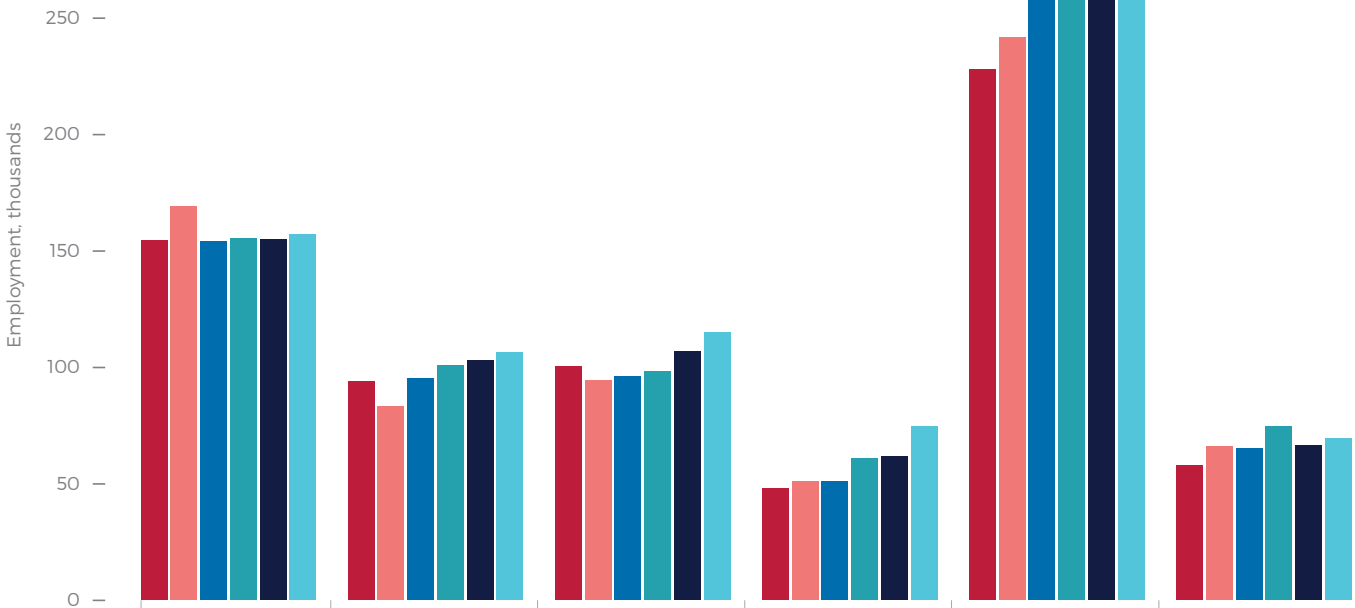
INCREASING DEMAND FOR ICT WORKERS[21] ACROSS ALL INDUSTRIES

With rapid technological innovation and digitalization happening across the country, ICT work is in steady and growing demand across Canada's major industries.

ICT employment has grown the most in the finance and insurance industry (6.5% CAGR), followed by professional, scientific and technical services (3.6% CAGR) and public administration (2.7% CAGR).

Figure 5 shows the growing trend toward ICT employment in major Canadian industries from 2011 to 2016.

Figure 5:
Employment of ICT workers in major industries, 2011–2016



	Manufacturing	Wholesale Trade	Information and cultural industries	Finance and insurance	Professional, scientific and technical services	Public administration
2011	154.3	93.9	100.3	48	227.8	57.7
2012	169.1	83.2	94.1	50.7	241.7	65.7
2013	154.1	94.9	96.1	50.8	264.8	65
2014	155.1	100.8	98.2	60.8	274.9	74.3
2015	154.7	102.9	106.7	61.5	274.3	66.5
2016	156.9	106.2	114.8	74.7	291.8	69.3

Year, Industries

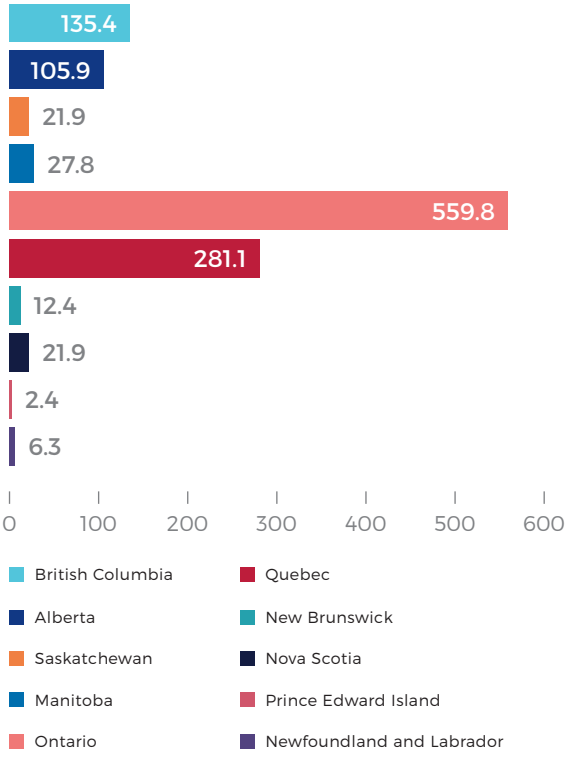
Source:
ICTC, Statistics Canada Labour Force Survey, 2011–2016

[21] See Appendix I for ICTC's updated list of ICT NOC codes.

ICT EMPLOYMENT BY PROVINCE

As of 2016, approximately 560,000 ICT workers are employed in Ontario, which accounts for 47%[22] of all ICT workers across Canada. The manufacturing sector—especially road transportation equipment manufacturing for complete vehicles and vehicle parts—is the biggest employer of ICT professionals such as industrial instrument technicians and mechanics, electrical and electronics engineers and computer engineers.

Figure 6:
ITC employment by province (in thousands)



Source:
ICTC, Statistics Canada Labour Force Survey, December 2016

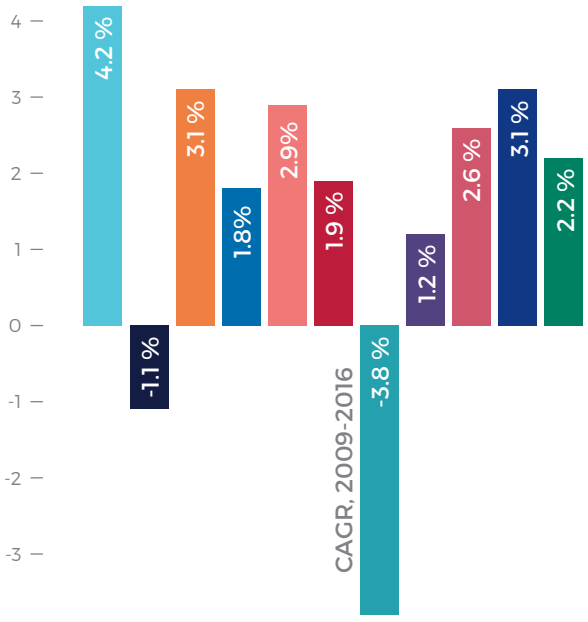
In 2016, there were about 281,000 ICT workers in Quebec, and about 135,000 in British Columbia.

In Quebec, the computer and electronic product manufacturing and aerospace product and parts manufacturing sectors are the biggest employers of ICT professionals. There has been fierce competition for ICT talent between these two industries.[23] In British Columbia, information and cultural industries (including publishing, the film industry, sound recording, broadcasting, telecommunications, and data processing and hosting services) are major employers of ICT professionals.

From 2009 to 2016, British Columbia had the highest ICT employment growth rate of 4.2% among all provinces, followed by Newfoundland and Labrador and Saskatchewan, both of which posted a growth rate of 3.1%. Ontario and Quebec have maintained moderate ICT employment growth rates of 2.9% and 1.9%, respectively.

Figure 7 shows the employment growth rates of employment in 10 provinces compared with that of Canada as a whole.

Figure 7:
ICT employment growth rate by province, 2009 to 2016



Source:
ICTC, Statistics Canada Labour Force Survey, December 2009–2016

[22] Source: Statistics Canada Labour Force Survey, December 2016.

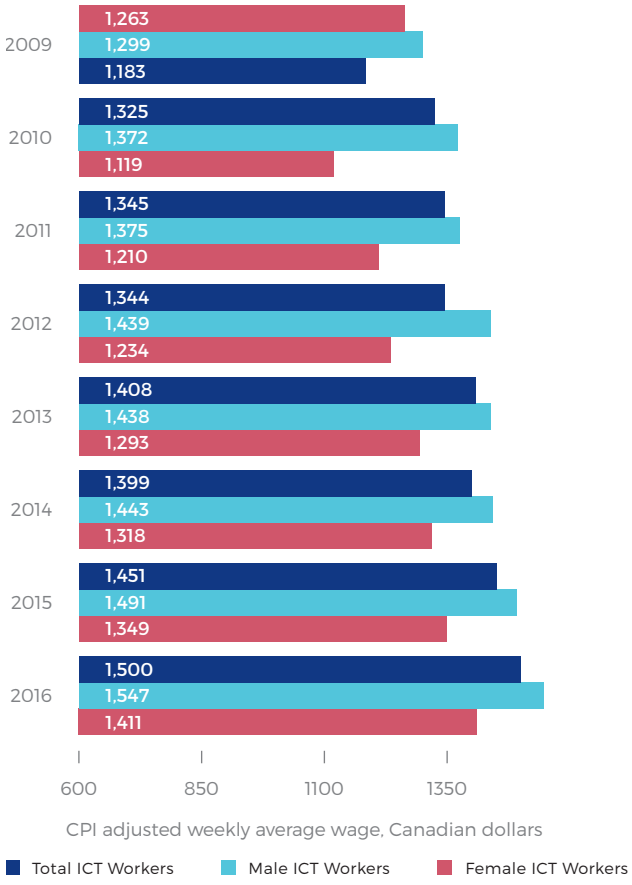
[23] Source: Ngoc Huynh (Chief Analyst at Investissement Quebec), March 21, 2017.

THE GENDER GAP

Of the 1,220,000 ICT professionals working across all industries, 854,000 of them are males and 366,000 of them are females. Female ICT workers account for only 24%[24] of the ICT workforce. This is the result of a lower labour force participation rate for women than men, and highlights the importance of attracting more women in ICT careers.

The employment gender gap is not the only imbalance among ICT talent. Figure 8 shows wages by gender from 2009 to 2016[25]. There is a prevalent trend of wage gender discrepancy for ICT occupations. In 2016, female ICT workers earned $136 in weekly wages less than their male counterpart, slightly better than the wage gap in 2015 of $142.

Figure 8:
Average weekly wage rate across ICT occupations by gender, 2009–2016

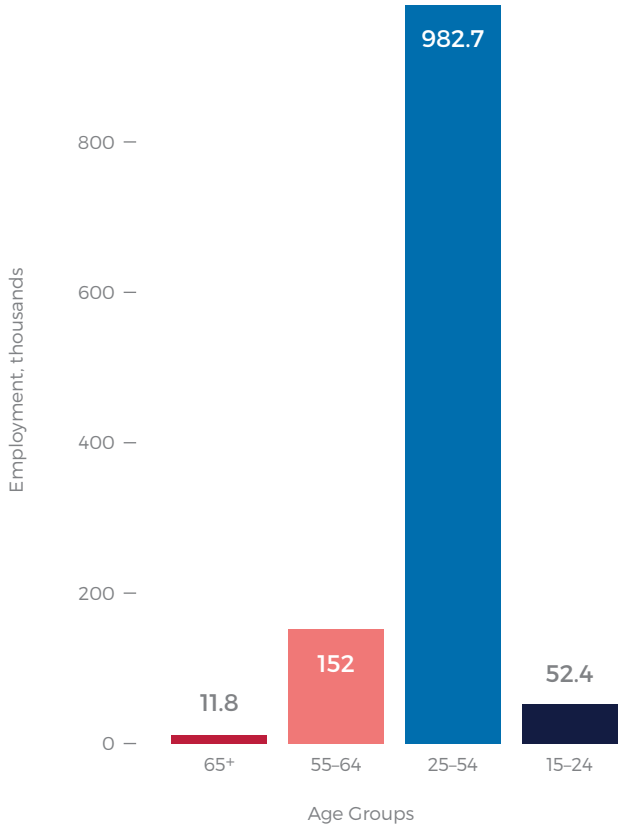


Source:
ICTC, Statistics Canada Labour Force Survey, December 2009–2016

AGING WORKFORCE AND INCREASING YOUTH UNEMPLOYMENT RATE

The ICT workforce is steadily aging. Separating ICT professionals into age groups (Figure 9), the majority of the workforce is between 25 to 54 years of age. ICT workers who are 15 to 24 years old account for only 4.4% of the total ICT workforce. In comparison, the nearing-retirement group (55 to 65 years old) accounts for 12.7% of the ICT workforce.

Figure 9:
ICT employment by age group



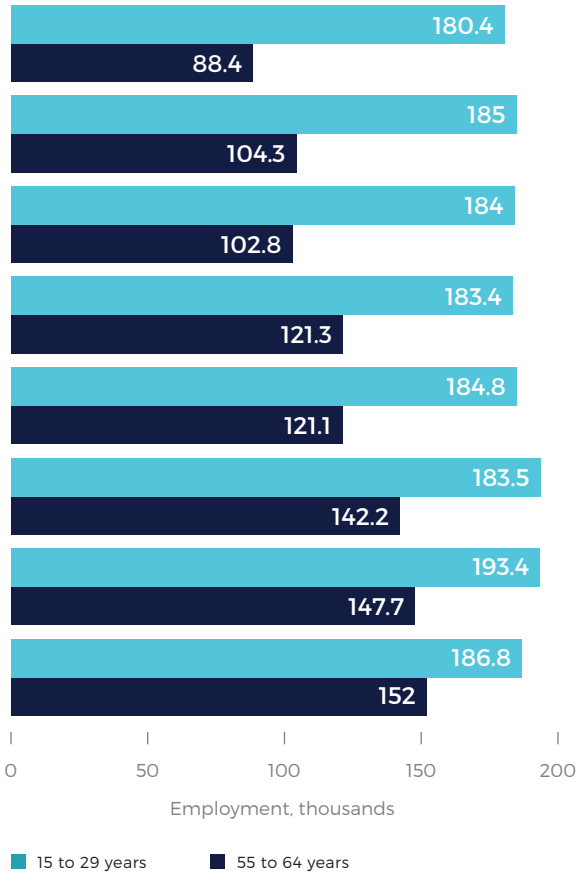
Source:
ICTC, Statistics Canada Labour Force Survey, December 2016

[24] Note, the proportion of woman employed in ICT roles is calculated based on ICTC's updated list of ICT NOC codes. Please refer to Appendix I for details.

[25] The average weekly wage is calculated based on in-demand ICT occupations. Please refer to the section "Top five in-demand ICT occupations" on page 17 for details.

ICTC has further studied historical employment data for these two groups (Figure 10), concluding that, from 2009 to 2016, the employment growth rate of the youth group (15 to 29 years old) was 0.5% CAGR, compared to 8.05% CAGR of the nearing-retirement group. From 2015 to 2016, employment of ICT workers 15 to 19 years of age decreased to 6,600; in comparison, employment of workers who were between 55 to 65 years old increased by 4,300 individuals.

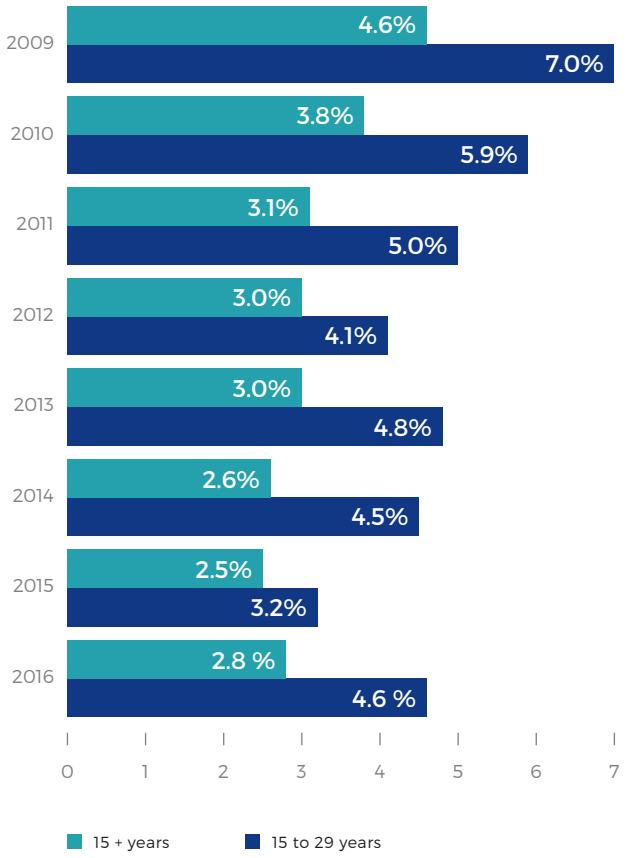
Figure 10:
Employment trends by age group, 2009–2016



Source:
ICTC; Statistics Canada Labour Force Survey, 2009–2016

While youth are actively seeking employment after graduation, the main impediment to securing employment remains one of having their first experience. A combination of Co-op and internship programs will go a long way to building pathways to succeed in the job market.

Figure 11:
Unemployment rate by age group, 2009–2016

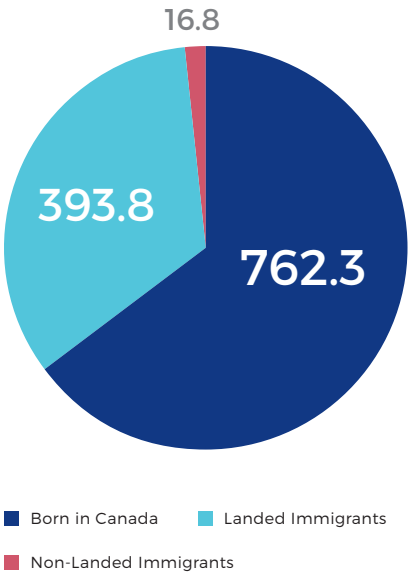


Source:
ICTC; Statistics Canada Labour Force Survey, 2009–2016

IMMIGRANT EMPLOYMENT IN ICT

In 2016 394,000 ICT professionals were landed immigrants. The ICT talent supply coming from the immigration stream has experienced fast growth, with a 6.7% employment growth rate from 2009 to 2016. In comparison, growth of ICT talent born in Canada was only 0.7%. With aging domestic talent and a decreasing number of youth workers in the field, attracting skilled digital workers worldwide is the immediate solution for industry leaders to grow their businesses and reduce opportunity costs caused by talent scarcity.

Figure 12:
ICT employment by immigration status, 2016



Source:
ICTC; Statistics Canada Labour Force Survey, December 2016

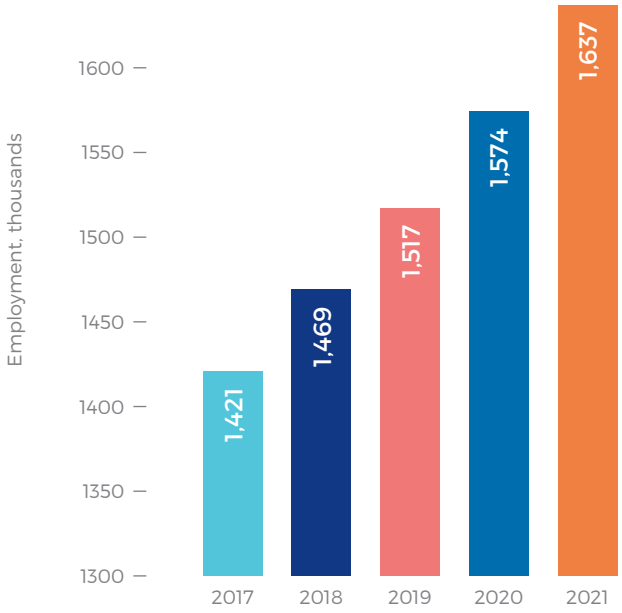
> "What Canada needs is efficient access to the best and brightest Internationally Educated Professionals (IEPs) to help technology industries transform and grow here in Canada and to add value to an economy that is languishing while transitioning from resources to innovation."
>
> —JAYSON HILCHIE, PRESIDENT AND CEO OF THE ENTERTAINMENT SOFTWARE ASSOCIATION OF CANADA

CANADA'S FUTURE DIGITAL WORKFORCE

Our predictions show that Canada's digital economy will continue to grow significantly over the next five years. Canada's stable political and economic environment, favourable global trade position and technological innovations are the driving forces behind the rapidly expanding ICT sector as well as the increasing demand for ICT talent.

A skilled workforce will be crucial to our country competing and thriving globally—and this will be especially true for the SMEs that represent a majority of our economy. In a baseline scenario, ICTC forecasts that, by 2021, the employment in our country's digital economy will reach 1,637,000, with an average growth rate of 3.6%.[26]

Figure 13:
Employment in Canada's digital economy, 2017–2021

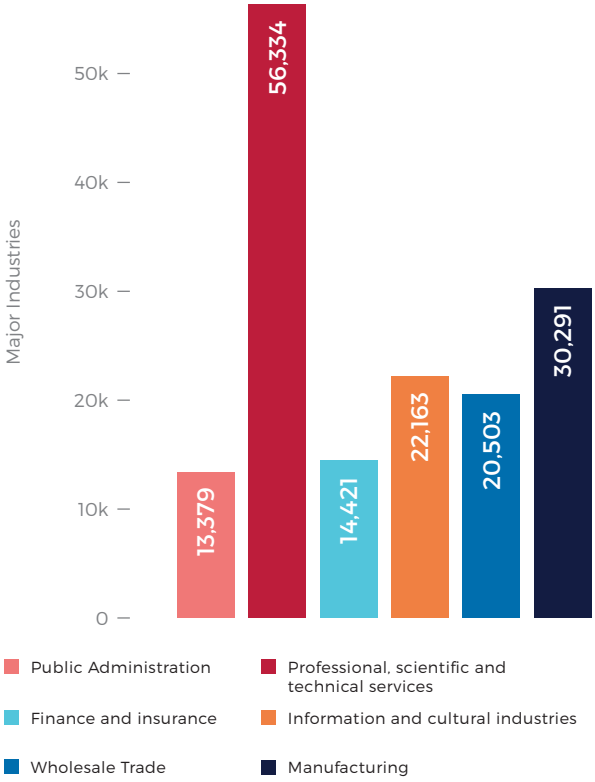


Source:
ICTC, 2017

26 Appendix III shows the detailed forecasting results for all 10 provinces.

By 2021, approximately 216,000 new jobs will need to be filled. Figure 14 shows the forecasted demand for ICT workers by major industry in Canada.

Figure 14:
Labour demand for ICT employment as of 2021, by major industry



Source:
ICTC, 2017

In 2016, there were approximately 1,220,000 ICT professionals working in Canada's digital economy. 53% of them were working in non-ICT industries, which indicates an increased prevalence of technology across all sectors of the Canadian economy. By 2021, the proportion of ICT workers who are working in non-ICT industries will increase to 84%.

This growing demand for ICT professionals is being created by transformative and rapid advancements of technology, particularly in the five key emerging technologies discussed earlier in this report: VR and AR, 3D printing, blockchain, AI and 5G mobile technology.

Virtual and Augmented Realities (VR and AR)

Pokémon Go's popularity is a tipping point for VR, and it also has brought both consumers and business users' attention worldwide to AR and VR. Not only impacting the gaming industry, VR and AR also have the potential to boost many other major sectors, such as real estate, health care, construction, commerce, engineering, education and more. For instance, AR has been applied in military, space industry and the medical field, such as flight and surgery simulators and simulated environment training.

Occupations that will be impacted by this technology include:

- computer and information systems managers
- computer engineers (except software engineers and designers)
- database analysts and data administrators
- computer programmers and interactive media developers
- graphic arts technicians
- engineering managers
- information systems analysts and consultants
- software engineers and designers
- industrial instrument technicians and mechanics
- graphic designers and illustrators
- user support technicians
- technical sales specialists—wholesale trade

3D Printing

The transformative impact of 3D printing on sectors such as manufacturing, technical services and trade will need ICT talent (e.g., industrial instrument technicians and electronic service technicians), to capture and help realize the economic opportunities offered by 3D printing technology.

Occupations that will be impacted by this technology include:

- computer and information systems managers
- computer engineers (except software engineers and designers)
- computer programmers and interactive media developers
- graphic arts technicians
- engineering managers
- software engineers and designers
- industrial instrument technicians and mechanics
- graphic designers and illustrators
- manufacturing managers
- electrical and electronics engineers
- electrical and electronics engineering technologists and technicians
- electronic service technicians (household and business equipment)

5G Mobile

The global 5G value chain will generate $3.5 trillion in output, outweighing the current value of today's entire mobile value chain, and supporting 22 million jobs in 2035[27]. Its improved capacity to handle a significantly greater number of devices and more efficient data transmission will be able to support applications that require high reliability and ultra-low latency connectivity. Due to these transformative features of 5G, its applicability could vary from the public administration industry to manufacturing and from financial services industry to information, culture and recreation sector.

Occupations that will be impacted by this technology include:

- user support technicians
- computer engineers (except software engineers and designers)
- engineering managers
- industrial instrument technicians and mechanics

Blockchain

The blockchain technology will transform the financial services industry significantly. With industries like financial services, retail, and energy further developing their blockchain infrastructure, ICT professionals, such as (e.g., database analysts, computer programmers, interactive media developers, software engineers and designers) will be in high demand.

Occupations that will be impacted by this technology include:

- computer and information systems managers
- computer engineers (except software engineers and designers)
- database analysts and data administrators
- computer programmers and interactive media developers
- engineering managers
- information systems analysts and consultants
- software engineers and designers
- user support technicians

Artificial Intelligence (AI)

Besides the significant potential for retail, manufacturing and health sectors, AI will continue to create economic advancement in banking services, transportation and more.

Occupations that will be impacted by this technology include:

- computer and information systems managers
- computer engineers (except software engineers and designers)
- database analysts and data administrators
- computer programmers and interactive media developers
- engineering managers
- information systems analysts and consultants
- software engineers and designers
- industrial instrument technicians and mechanics
- health information management occupations

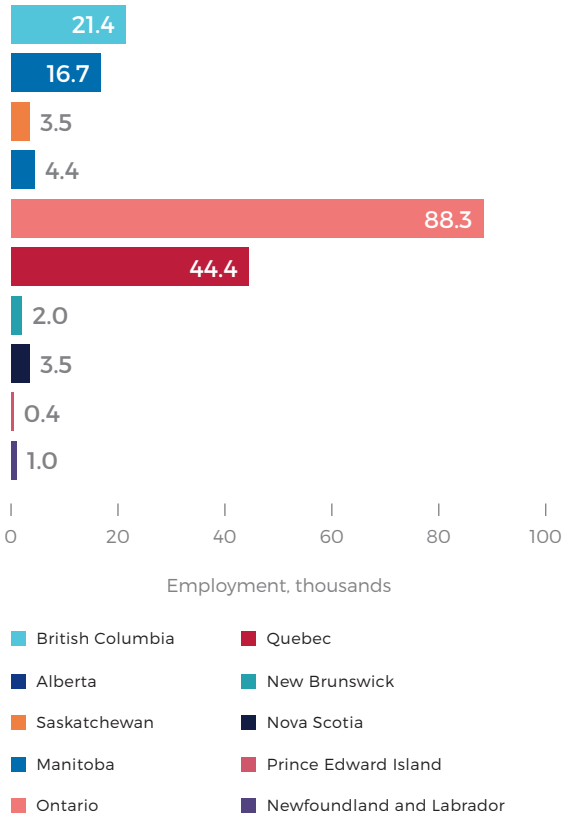
27 Russell & Norvig (2003).

28 Please see Appendix III for detailed provincial employment forecasting results for 2017 to 2021.

ICT EMPLOYMENT GROWTH BY PROVINCE

Figure 15 shows the forecasted results of ICT employment growth for all 10 provinces in Canada by 2021.[28] Ontario, British Columbia and Quebec are the three provinces that will need the most ICT workers by 2021.

Figure 15:
Projected ICT employment growth, by province, 2017–2021



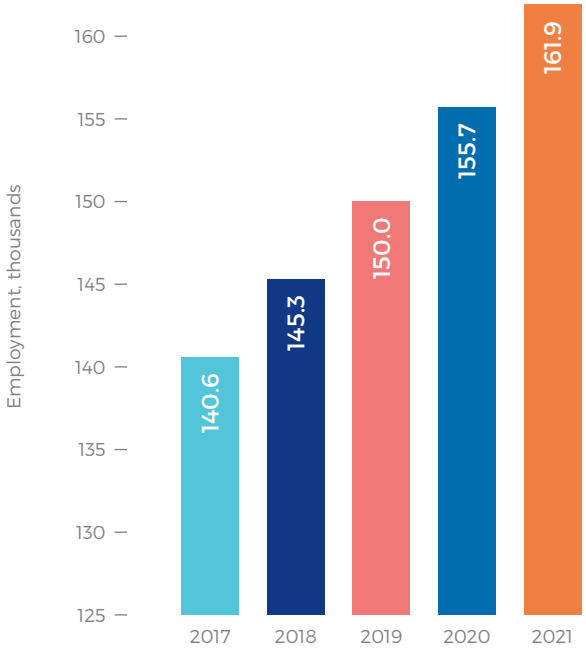
Source:
ICTC, 2017

British Columbia

British Columbia will experience a significant increase in ICT employment by 2021. The province's vibrant and diverse hub of technology is powering this upsurge in the ICT labour market. Over the last 10 years, British Columbia has established an emergent technology community that consists of 940 tech companies. These companies contributed $15.5 billion to Canada's GDP in 2014.[29]

Increasing access to capital has played a significant role in boosting the province's ICT sector, as well as its interactive and digital media (IDM) subsectors. For example, in 2013, the federal government launched a venture capital action plan that aimed to deploy $400 million in new capital.[30] In 2015, the provincial government announced the creation of a $100-million technology innovation venture fund to further support local firms.[31]

Figure 16:
British Columbia's projected employment rates, 2017–2021



Source:
ICTC, 2017

29 2016 BC technology report card: Scaling up BC's tech ecosystem, KPMG, Oct. 2016: http://www.wearebctech.com/advocacy/publications/publication/industry-reports/2016-kpmg-bc-tech-report-card

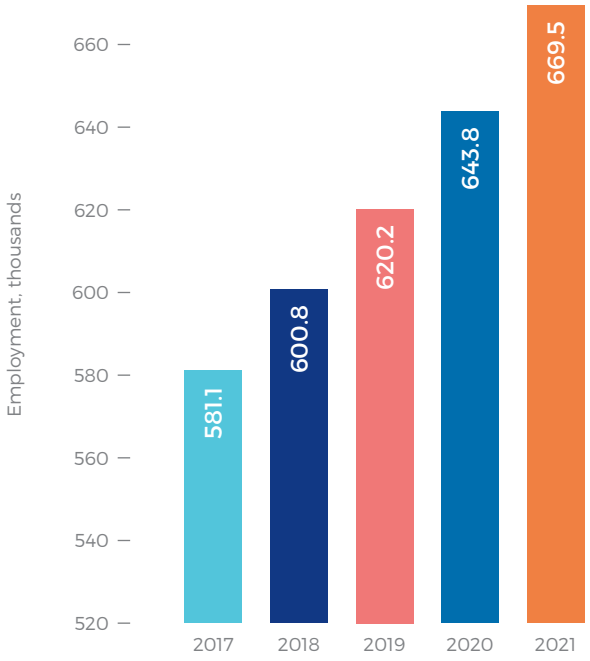
30 2016 BC technology report card: Scaling up BC's tech ecosystem, KPMG, Oct. 2016: http://www.wearebctech.com/advocacy/publications/publication/industry-reports/2016-kpmg-bc-tech-report-card

31 2016 BC technology report card: Scaling up BC's tech ecosystem, KPMG, Oct. 2016: http://www.wearebctech.com/advocacy/publications/publication/industry-reports/2016-kpmg-bc-tech-report-card

Ontario

In Ontario, approximately 88,000 ICT jobs will be created by 2021, and total employment in the ICT sector will reach about 670,000. As a manufacturing-focused province, in the next five years Ontario will experience growth powered by technologies like AI (especially in the autonomous car sector), 5G mobile and 3D printing.

Figure 17:
Ontario's projected employment rates, 2017–2021



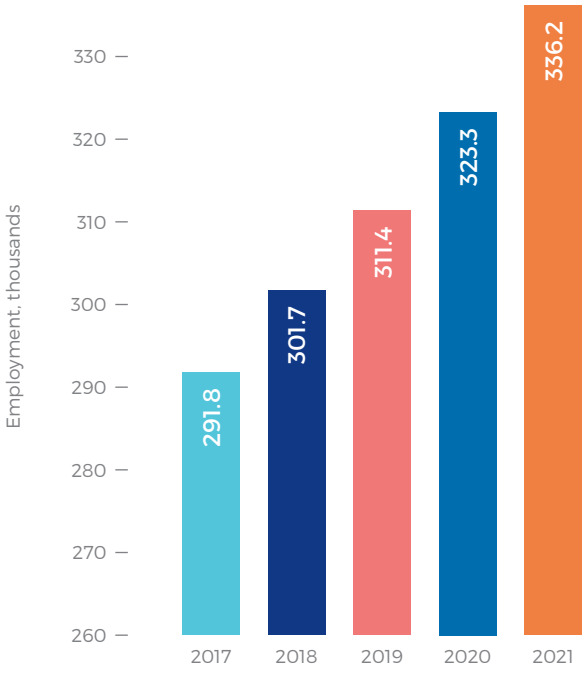
Source:
ICTC, 2017

Quebec

Aerospace and gaming are the two largest industries that hire ICT talent in Quebec. With the emergence of 3D technology, AI and 5G mobile, Quebec will benefit from labour and machine productivity improvements that will create cost savings. Aerospace industry leaders will be able to invest more in research and development programs and expand the scope of their businesses.

The growing advancement of VR and AR will continue to drive growth in gaming and other computer and electronic product manufacturing. Skilled ICT workers are the foundation of this industry's growth. ICTC forecasts that, by 2021, approximately 44,400 ICT workers will be in demand and total employment in the ICT sector will increase to 336,200.

Figure 18:
Quebec's projected employment rates, 2017–2021



Source:
ICTC, 2017

TOP FIVE IN-DEMAND ICT OCCUPATIONS

Canadian ICT companies are already challenged by a labour supply shortage in the highly skilled ICT occupations that support technological innovation. Being able to staff critical positions is an immediate challenge for Canadian ICT businesses.

Adopting an approach that combines both quantitative and qualitative analyses, ICTC analyzed five key labour market indicators—employment growth, employment growth rate, labour market tightness, overtime hours growth rate and wage growth rate—for each ICT occupation. We then provided a picture of which occupations are both in demand and in short supply.

The top five ICT occupations with labour shortages according to ICTC's research are:

1. computer and information systems managers
2. computer engineers (except software engineers and designers)
3. database analysts and database administrators
4. computer programmers and interactive media developers
5. graphic arts technicians

These five ICT occupations share the following characteristics:

- Broad potential to grow the scale and scope of the Canadian economy, leveraging one or many of the technology drivers identified above.
- Greater potential for job mobility between sectors, and therefore less risk of being out-phased from the job market in a changing economy.
- Can be easily re-skilled or up-skilled to meet new industry demands given strong baseline of education.
- Potential for career progression with minimal training costs (hence business growth) compared to occupations with skills that are narrowly defined and have limited career prospects.

The following ICT jobs are also in high demand:

- information systems analysts and consultants
- industrial instrumentation technicians and mechanics
- software engineers and designers
- engineering managers
- graphic designers and illustrators
- user support technicians

Against the pressing backdrop of ICT worker scarcity, Canada must secure top ICT talent with the highest potential to grow the scale and scope of our economy.

CONCLUSION AND POLICY RECOMMENDATIONS

The recent 2017 Federal Budget set a strong foundation for addressing the digital skills and labour shortages, and ICTC looks forward to enabling many of the recommendations to follow.

The Canadian economy is rapidly becoming digital and increasingly global in nature. With its favorable political and business climate, in addition to a vibrant digital ecosystem, Canada is poised to become a leader in the global digital economy. Having a steady supply of skilled talent is critical to support this fast growing economy.

Canada must overcome talent shortages, skill gaps and the slow pace of digital adoption to ensure its continued status as a globally modern economy. The competitive pressure on employers seeking new talent in the ICT sector is extremely high. In a survey done by ICTC, more than 53% of organizations cited attracting and retaining skilled employees as one of their top human capital challenges. The demand for top ICT talent continues to grow and has resulted in expanding career options for ICT professionals, which only places further competitive pressure on employers who need skilled workers.

CULTIVATING A SKILLED YOUTH ICT TALENT SUPPLY STREAM

The quest for talent in Canada's evolving, dynamic digital economy is predicted to intensify during the next five years due to demographic shifts and retiring workers. As discussed above, Canada has been coping with an aging ICT workforce along with a weak growth of young ICT workers. From 2015 to 2016, the employment for ICT workers who are between 15 and 29 years of age decreased by 6,600, while employment of those who are between 55 and 65 years old increased by 4,300. Over the same period of time, the unemployment of the young ICT workforce increased by 1.4%, and outweighed 1.8% of that among the overall ICT workforce.

Policy makers, industry leaders and educators must collaborate to help grow youth ICT talent, from elementary and secondary education, through to post-secondary education and build pathways to employment.

Elementary and Secondary Education

Youth are tomorrow's innovators, entrepreneurs and business enablers. The ICT profession can be an excellent entry point for today's graduates, yet Canada does not have enough young people choosing ICT or science, technology, engineering and mathematics (STEM) disciplines in school, nor as career choices to meet its current and future needs. Learning STEM based topics, such as computer science, math and physics in elementary and secondary school serve as an important gateway to future education and careers in ICT.

While Canadian students on average perform well in STEM subject areas, students continue to opt out of STEM based learning as they progressively age. While students say that science can be fun even by middle school, few express an interest in taking STEM at the secondary and post-secondary levels. Since interest in STEM tends to decrease with age, teaching computational learning and digital literacy in an engaging way at an early age can help build foundational skills and boost interest in STEM topics. Additionally, today's youths incorporation of creative, fun and challenging ways to use the latest advanced technology in the classroom could further help engage students in STEM.

This can only be achieved with the support of educators and it is critical that teachers have the resources, knowledge, and tools required to provide an enriched STEM learning environment. Support mechanisms such as training and professional development networks are critical in equipping educators with necessary resources.

Our recommendations include the following:

- Policy makers should facilitate efforts to incorporate computer science into the K-12 curriculum by developing, in consultation with the provinces and industry, a standard national curriculum with lesson plan materials. Specifically, policy makers should consider including the following components:
  - Computational thinking for students in early grades;
  - Coding for students in intermediate grades;
  - Virtual reality and augmented reality, 3D printing, cyber security, networking for students in advanced grades;
  - Hands-on, experiential learning activities;
  - Information about career paths and occupational roles that require ICT skills;
- Industry, school administration, and government should increase the amount of resources, support, professional development opportunities, and recruitment of STEM background or digitally skilled teachers in elementary and secondary schools.

Post-Secondary Education

Global economic growth and technological advancements have intensified the need for a highly skilled, innovative and adaptable workforce. It is increasingly important that Canada has a steady stream of graduates who have the ICT technical and complementary skills—such as business, entrepreneurial, and interpersonal skills needed to be innovative and competitive global leaders. However, there is a significant gap between the in-demand skills in the marketplace and the degrees that students are completing, leaving many upon graduation highly educated, but with no secure employment prospects.

Canada's digital economy relies heavily on students enrolled in post-secondary ICT and STEM programs, who graduate with the specific technical skills needed to support the advancement of our innovation agenda. While there is a flow of ICT graduates and the annual ICT enrolment rate has increased by 24% since 2010, the total output of ICT graduates is still expected to be insufficient to satisfy labour market needs. For example, 2015 saw just under 30,000 graduates from ICT related degrees, nationwide, a figure that represents only a fraction of the total volume of workers needed to fill the digital economy's current and future demand.

Gaining practical, and on the job experience is also a crucial component for success. International surveys have shown that paid internships provide valuable hands-on experience for workers and provide long-term employment benefits. Many major technology employers will use internships as a competitive process to determine which interns to keep as permanent employees. Students benefit immensely from these experiences because they allow them to work on the practical side of their studies and also apply their knowledge to projects that have tangible outputs and outcomes. The opportunity to work in an industry setting also helps students build the cultural, interpersonal, and business skills that are critical in a diverse global economy. While numerous Canadian universities and colleges offer work-integrated learning opportunities, more is needed to strengthen the talent pipeline.

Our recommendations include the following:

- Industry should be more actively engaged with post-secondary institutions on the needs of their company, their sector, and the Canadian economy.
- Educators should examine ways to be more responsive to the skills graduates need to excel, in collaboration with industry, by designing and modifying curriculum effectively and on a regular basis.
- Policy makers, industry and education systems should continue to collaborate on providing workplace experiential learning opportunities in terms of coops and internships for students to improve youth readiness for the workplace.

Career Transition

One of the most critical challenges is that ICT graduates often struggle entering the workplace after post-secondary studies. The benefits to the Canadian economy of having youth seamlessly transition from post-secondary education to employment are clear. However, integrating technical and vocational training at the necessary scale is challenging, especially for SMEs. Without support, these companies do not have the time or financial resources to offer on-the-job training. Wage subsidies and upskilling programs for youth are proven approaches for bridging newly graduated youth into employment.

Additionally, encouraging young graduates to start their own businesses is also a proven way to reduce youth unemployment as well as to promote business growth in the ICT sector. Creating the right conditions to support and grow innovations through financial support for entrepreneurs provides new economic opportunities, expands the economy into new cutting-edge sectors and furthers potential employment prospects.

Our recommendations include the following:

- Federal government should increase the availability of wage subsidy and support for post-graduation short-term duration upskilling programs to enable youth to secure employment in ICT jobs.
- Continue to make Canada one of the best places to start a new company providing the best environment to develop and grow, including:
  - Access to capital for commercially viable ideas.
  - Access to a skilled workforce.
  - Access to global markets through free trade agreements.
  - Cost reduction and mitigation measures that accelerate the growth of companies including incubators and accelerator programs.
  - Mentoring and advisory services that can help new entrepreneurs manage challenges and grow.
  - Enable hubs to exchange best practices between would be entrepreneurs.

LEVERAGING A DIVERSE ICT WORKFORCE

Immigrants[32]

As population growth continues to decline, domestic skilled talent will become increasingly scarce. With immigrants representing more than one-third of ICT workers in Canada, they currently and will continue to play an increasingly pivotal role in addressing the digital talent shortage. However, Canada is not alone in this trend; nations like Denmark, Germany and the United Kingdom are also experiencing talent shortages. Global talent scarcity will boost the importance of securing highly skilled international workers. Furthermore, it will open global economies, enabled by FTAs like the Trans-Pacific Partnership, increase talent mobility as companies expand into new markets and help labour markets become further globalized. While Canada remains a popular destination for newcomers, particularly from Asia and Europe, the globalised nature of the digital economy compounded by domestic systemic barriers pose challenges for the rapid integration of immigrants into the ICT workforce.

Our success in the battle for global digital talent will depend on how organizations, government, policy makers, and industry overcome these obstacles and address the barriers facing talent and business. Implementing policies that allow businesses to efficiently and quickly secure international talent will be critical in this endeavour. Furthermore, devising policies, strategies, and programs, at the government and enterprise level, that eliminate the barriers individual newcomers face will allow for immigrants to integrate more quickly into the ICT workforce.

32 Please see ICTC's report Digital Economy Supply: The Immigration Stream, 2016: http://www.ictc-ctic.ca/studies-publications/. This report examines the labour market impacts of immigrants in Canada's digital economy and the importance of immigration as a competitive advantage for Canada.

Our recommendations include the following:

- Policy makers should devise a tech talent strategy to track the amount of talent coming to and leaving Canada and the implications FTAs have on the Canadian labour market.
- That specific provisions in future trade agreements should be included to regularly revisit the high demand digital occupations (regulated & non-regulated & based on Labour Market Information (LMI) forecasts) and allow for a free movement of labour without the need for Labour Market Impact Assessment (LMIA).
- Policy makers should make temporary allowances to hire above the cap limit in return for contributing financial support to developing the talent supply in Canada (quid pro quo policy).
- Federal and provincial policy-makers should work with industry and labour market-focused organizations to update the labour market information and national occupation classification codes used by immigration and workforce development staff for assessing the supply of and demand for emerging occupations.
- Industry and government should continue to invest in offering more training and development opportunities to promote continuous learning, advancement opportunities, workforce upskilling, and enhance immigrants' workplace communication skills.
- Industry should employ inclusive and skills-based recruiting techniques to overcome issues surrounding international credential and experience validation.

Women

Women represent a strong source of potential talent for the ICT industry. The case for their advancement and inclusion is clear. For example, a report by Credit Suisse found that there are significant benefits to increasing the representation of women on boards of directors. Based on an analysis of 2,360 companies worldwide, Credit Suisse found that the share price of companies with some female board representation outperformed those with no women on the board. The average return on equity for companies with at least one woman on the board over a six-year period was 16%, four percentage points higher than companies with no women on their boards. Given this data, a number of jurisdictions (including Canada, the United Kingdom, Australia, Norway and France) have undertaken several strategies, from targets to disclosure standards, to promote the advancement of women on boards and in executive positions.

However, there is a huge employment gender gap in the Canadian ICT workforce. In 2016, female ICT employment accounted for just 30% of the total ICT workforce, which signals that there is room for improvement in the female labour force participation rate.

Our recommendations include the following:

- The need to better understand the barriers to full participation in the ICT field by women, including the wage gap.
- The importance of sharing best practices in diversity and inclusion.
- The need to establish targets and an action plan to attract and retain female ICT talent to the field.
- Industry, educational institutions and policy makers should tailor existing ICT learning opportunities (e.g., coding lessons, leadership courses) to encourage participation from women in the field.

Indigenous Peoples[33]

As the quest for talent intensifies, our success in remaining a competitive and innovative nation will depend on how organizations, government, policy makers, and industry leverage the opportunities Indigenous people offer the digital economy and Canada as well. Despite being one of the fastest-growing populations in Canada, Indigenous peoples remain significantly under-represented within Canada's labour force. Even today, Indigenous peoples only comprise approximately 1.2% of all ICT professionals nationally. Moreover, often overlooked, Indigenous peoples are not always seen as a potential solution to filling the existing labour gaps that are creating roadblocks for Canadian companies seeking to increase their presence on a global scale.

An increase in labour force participation rates among Indigenous peoples would translate into a greater supply of skilled talent for the digital and overall economy. Estimates predict that Canada's Indigenous workforce could increase by more than 45,000 by 2021, more than 72,000 by 2026, and approximately 103,500 by 2031[34] with some predictions as high as 145,000 workers by 2031.[35] As automation and technological advances continue to change the type of work we do and the nature of work itself, the ability to recruit homegrown talent, such as Indigenous peoples, to fill these jobs becomes more crucial than ever.

33 ICTC will publish a study on Indigenous peoples in ICT in April 2017.

34 Rick Miner (2014). The Great Canadian Skills Mismatch: People Without Jobs, Jobs Without People and More.

35 Centre for the Study of Living Standards (2015). Closing the Aboriginal Education Gap in Canada: Assessing Progress and Estimating the Economic Benefits.

Additionally, building trust with Indigenous communities is a necessary ingredient in the move towards reconciliation, as well as a critical aspect to acknowledging past traumas and the marginalization that Indigenous peoples have experienced in the labour market and our society. Implementing policies that allow us to build Canada's Indigenous ICT talent pool in a collaborative and inclusive way with Indigenous communities themselves is important in securing our collective social and economic prosperity. In order to do so, we recommend the following actions:

- Industry and associations in collaboration with Indigenous communities working together to build awareness of ICT use among Indigenous communities and how to incorporate digital technologies into the community.
- Policy makers, industry, and associations should continue to expand high-speed broadband connectivity to Indigenous communities. This may be facilitated through strategic partnerships between Indigenous economic development groups and industry—including SMEs— that provide Internet connectivity resources.
- Industry, educators, and associations should work with Indigenous communities to highlight the work of Indigenous role models employed in ICT, especially to Indigenous youth. Media, government and industry coverage displaying success stories of Indigenous workers in ICT and STEM professions can help to foster increased awareness and enhanced understanding of the career opportunities in the digital economy.
- Educators, industry, and policymakers should improve access to and increase the number of co-operative education, internship, and wage subsidy opportunities for Indigenous peoples specific to ICT. Policymakers should also consider expanding enrollment criteria for Indigenous wage subsidy and internship programs so that they are not always exclusively tied to age, allowing career transitioners and mature students to participate as well.

These recommendations form part of Canada's national digital talent strategy, Digital Talent: Road to 2020 and Beyond, which was designed to ensure Canada's talent will be well-prepared to succeed in our increasingly digital and global economy.

APPENDICES

APPENDIX I: ICT NATIONAL OCCUPATION CODES (NOCS)

0131	Telecommunication carriers managers
0211	Engineering managers
0213	Computer and information systems managers
0911	Manufacturing managers
1252	Health information management occupations
2133	Electrical and electronics engineers
2147	Computer engineers (except software engineers and designers)
2171	Information systems analysts and consultants
2172	Database analysts and data administrators
2173	Software engineers and designers
2174	Computer programmers and interactive media developers
2175	Web designers and developers
2241	Electrical and electronics engineering technologists and technicians
2242	Electronic service technicians (household and business equipment)
2243	Industrial instrument technicians and mechanics
2281	Computer network technicians
2282	User support technicians
2283	Information systems testing technicians
5222	Film and video camera operators
5223	Graphic arts technicians
5225	Audio and video recording technicians
5241	Graphic designers and illustrators
6221	Technical sales specialists - wholesale trade
9222	Supervisors, electronics manufacturing
9523	Electronics assemblers, fabricators, inspectors and testers

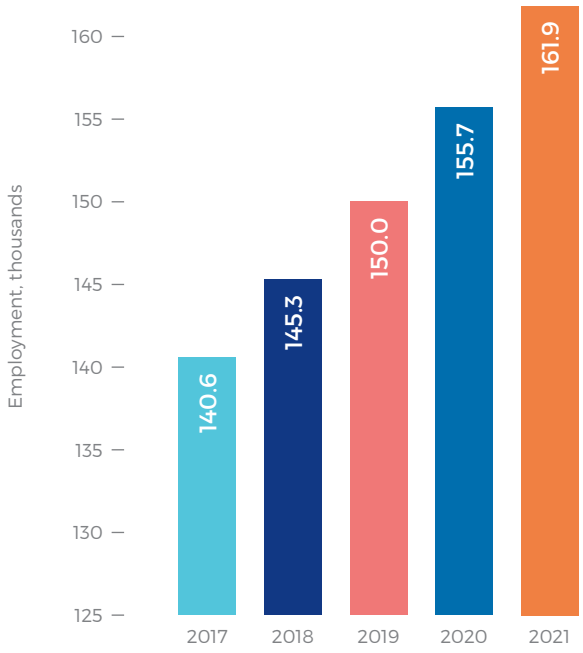
APPENDIX II: ICT NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEMS (NAICS)

3333	Commercial and service industry machine manufacturer
3341	Computer and peripheral equipment manufacturer.
3342	Communications equipment manufacturer
3343	Audio and video equipment manufacturer
3344	Semi-conductor and other electronic component manufacturer
3345	Navigational, medical and control instruments manufacturer
4173	Computer and communications equipment and supplies wholesale distribution
5112	Software publishers
5171	Wired telecommunications carrier
5172	Wired telecommunications carrier (except satellite)
5174	Satellite telecommunications
5179	Other telecommunications
5182	Data processing, hosting, and related services
5415	Computer systems design and related services
8112	Electronic and precision equipment repair and maintenance

APPENDIX III: ICT EMPLOYMENT FORECASTING RESULTS, BY Pprovince

British Columbia

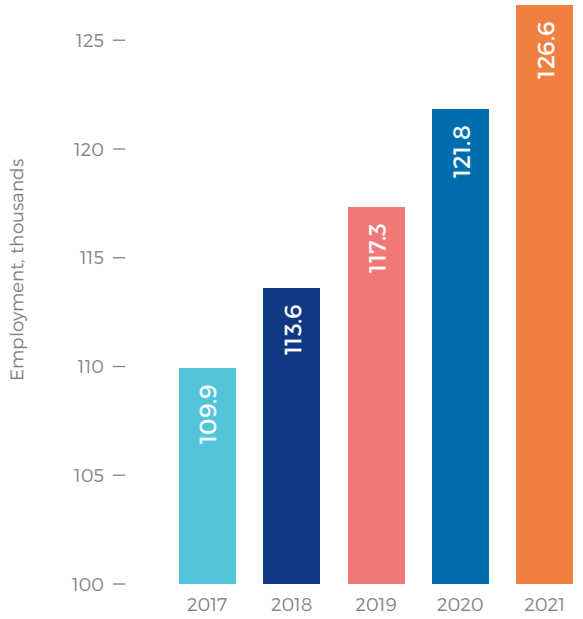
Figure A-1:
ICT employment forecasting for British Columbia, 2017–2021



Source: ICTC, 2017

Alberta

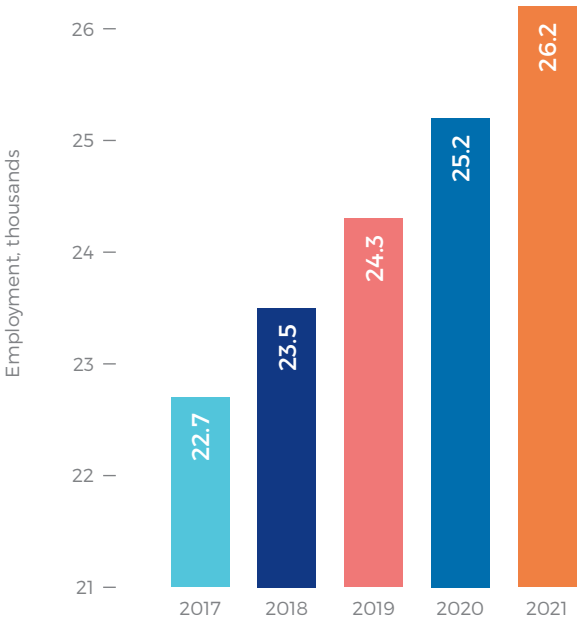
Figure A-2:
ICT employment forecasting for Alberta, 2017–2021



Source: ICTC, 2017

Saskatchewan

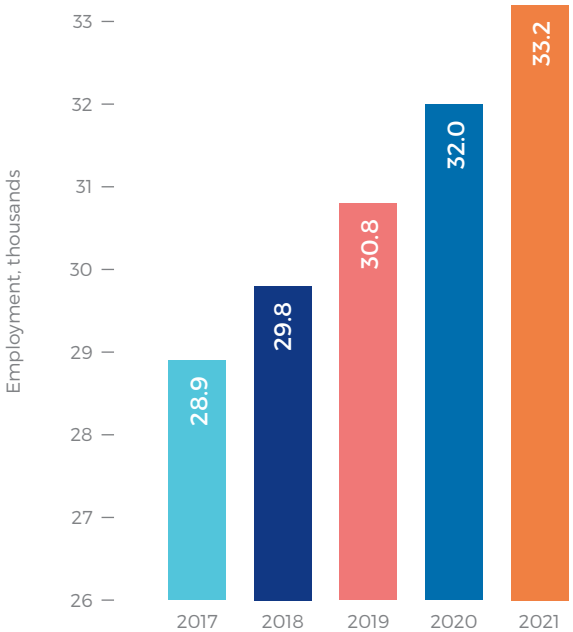
Figure A-3:
ICT employment forecasting for Saskatchewan, 2017–2021



Source: ICTC, 2017

Manitoba

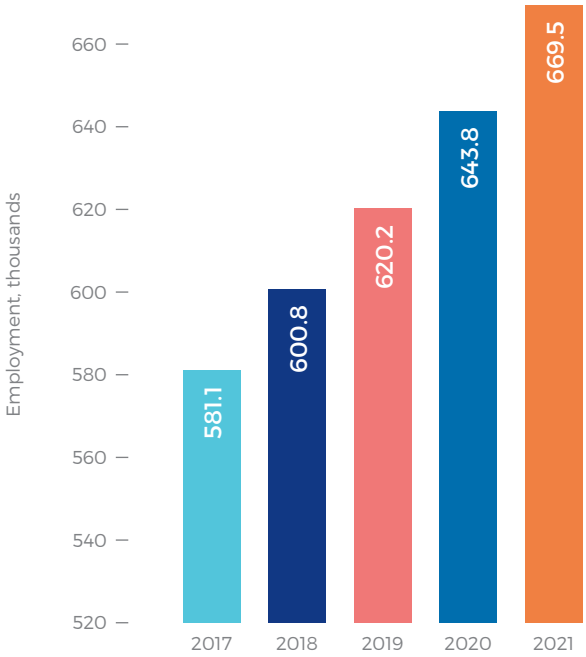
Figure A-4:
ICT employment forecasting for Manitoba, 2017–2021



Source: ICTC, 2017

Ontario

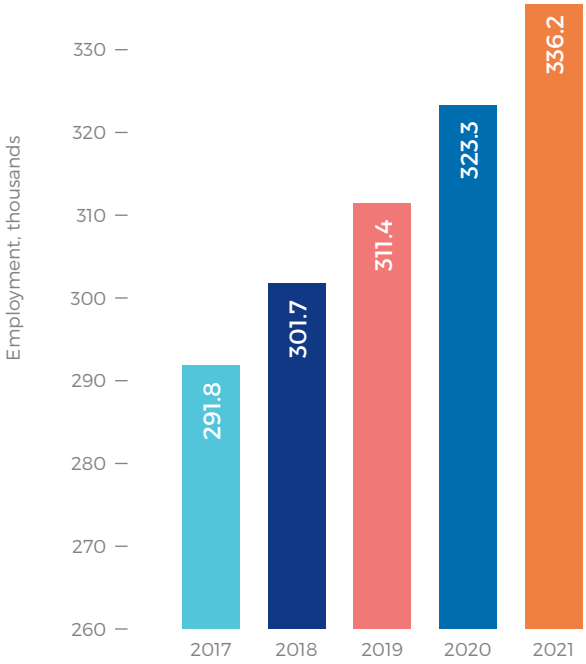
Figure A-5:
ICT employment forecasting for Ontario, 2017–2021



Source: ICTC, 2017

Quebec

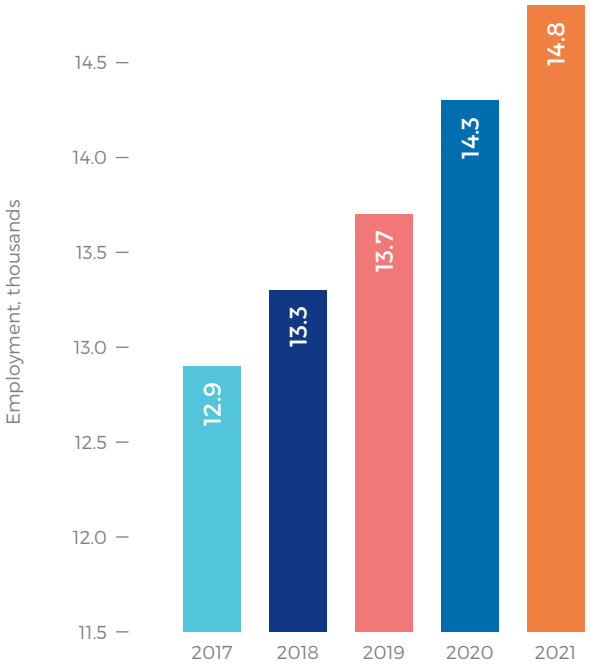
Figure A-6:
ICT employment forecasting for Quebec, 2017 –2021



Source: ICTC. 2017

New Brunswick

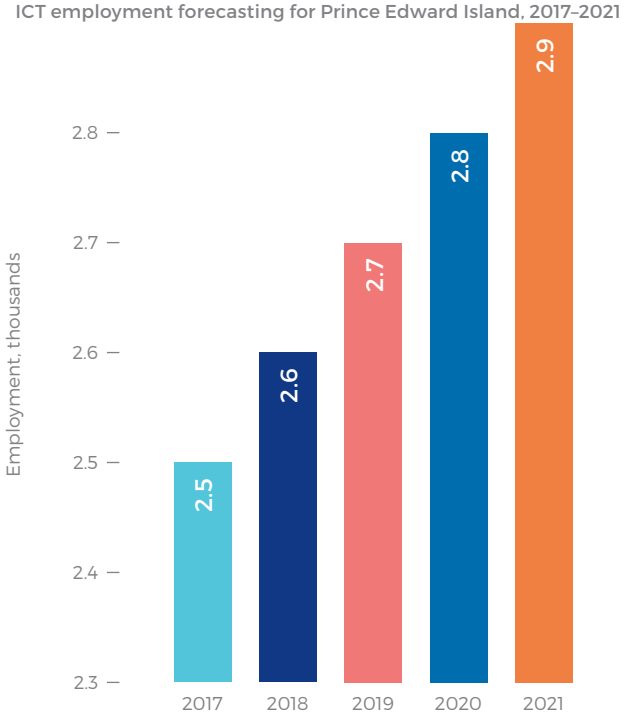
Figure A-7:
ICT employment forecasting for New Brunswick, 2017–2021



Source: ICTC, 2017

Prince Edward Island

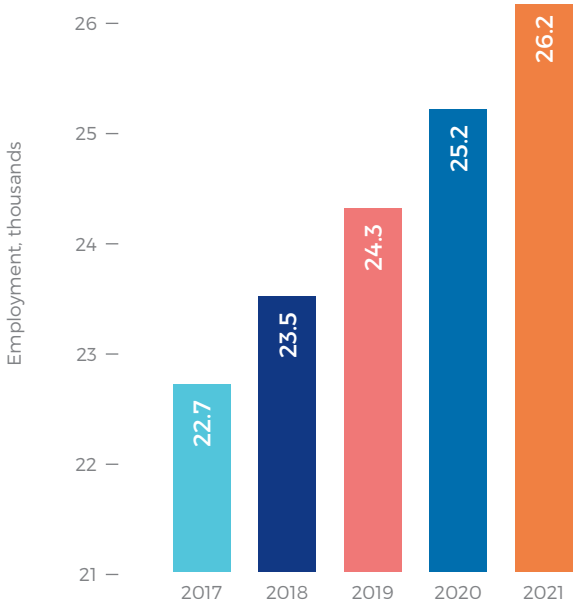
Figure A-8:
ICT employment forecasting for Prince Edward Island, 2017–2021



Source: ICTC, 2017

Nova Scotia

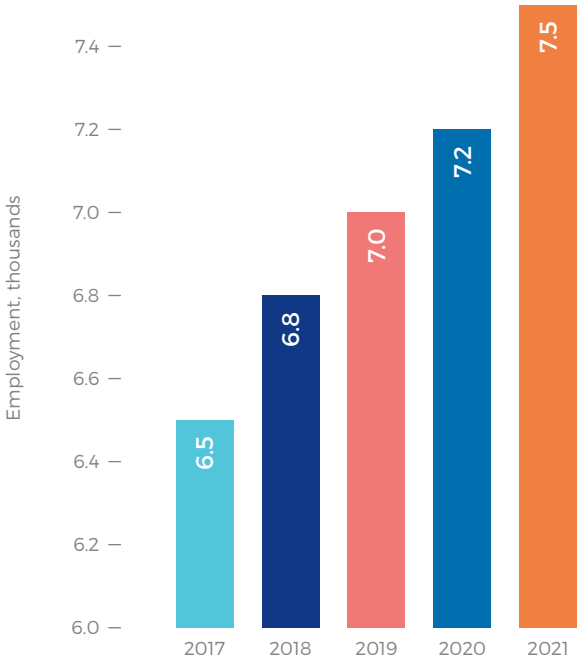
Figure A-9:
ICT employment forecasting for Nova Scotia, 2017–2021



Source: ICTC, 2017

Newfoundland and Labrador

Figure A-10:
ICT employment forecasting for Newfoundland and Labrador, 2017–2021



Source: ICTC, 2017

APPENDIX IV: ANALYTICAL FRAMEWORK AND METHODOLOGY

The authors of this report used the following framework and methodology to capture data and findings:

1. Study scope
   - Twenty-five National Occupation Codes (NOCs)
   - Fifteen North American Industry Classification System (NAICS) codes
2. Analysis of demand drivers and supply stream
   - Economic outlook and technology drivers
   - Demographics
3. Quantitative data
   - Statistic Canada Labour Force Survey, 2009 to 2016
4. Qualitative data
   - Literature review
   - Meta-analysis of in-demand skills

APPENDIX V: ACRONYMS

AI	Artificial Intelligence
AR	Augmented Reality
CETA	Comprehensive Economic and Trade Agreement
EU	European Union
EDC	Export Development Canada
FTA	Free Trade Agreement
GDP	Gross Domestic Product
ICT	Information and Communications Technology
ICTC	Information and Communications Technology Council
IoT	Internet of Things
IDM	Interactive Digital Media
IMF	International Monetary Fund
IT	Information Technology
LFS	Labour Force Survey
LMI	Labour Market Information
LMIA	Labour Market Impact Assessment
NAICS	North American Industry Classification System
NOC	National Occupational Classification
SMAAC	Social Media, Mobile, Analytics, Apps, and Cloud
SME	Small and Medium-Sized Enterprises
STEM	Science, Technology, Engineering and Mathematics
VR	Virtual Reality
3D	Three Dimensional
5G	5th Generation Mobile Networks