

October 2022

Canada's post COVID-19 recovery

The impact of the telecom sector
in 2021 and beyond



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Executive summary

In 2021, the telecom sector contributed almost \$75B in direct GDP and supported over 650K jobs in Canada. The sector is a key contributor to Canada's economic, social and environmental development, providing the connectivity that underpins and enables use cases in the digital economy, and connects Canadians across the country and with the world.

In 2021, the COVID-19 pandemic continued to disrupt the social and economic lives of Canadians. As the country adjusted to new norms (e.g., changes in business models and consumer behaviour) and public health measures eased, economic activity increased, resulting in real GDP growth of 4.6%.¹ Throughout the year, the connectivity provided by the telecom sector was important for maintaining economic and social activity and supported a range of positive outcomes for Canada, with the telecom sector contributing almost \$75B in direct GDP and supporting over 650K jobs.²

The telecom sector invested \$12.3B³ to expand and build on infrastructure, representing an average of approximately 19% of revenue in 2021, which is higher than the 14% of revenue average across peer telecom providers in the G7 and Australia.⁴ This is in addition to the \$8.9B invested in 2021 in acquiring new spectrum licences.⁵ These large capital investments helped to increase coverage, quality and affordability of telecommunication services in Canada, helping to make Canada a global connectivity leader. Canada has one of the highest quality wireless networks in the world,⁶ ranking 1st among G7 countries and Australia for average download speeds in 2021.⁷ Canada also had 99.7% mobile network coverage of homes, business and major transportation roads in 2020, with 100% coverage anticipated by 2026.⁸ In terms of wireline, Canada's household coverage of cable networks is 87% for 100 Mbps speeds and 76% for 1 Gbps speeds; this is higher than the EU which has 76% coverage for 100 Mbps speeds and 51% for 1 Gbps speeds.⁹

Average consumer prices of mobile plans across a range of data sizes have decreased in Canada; for instance, plans with 2GB and 5GB of data declined by 41% and 44% respectively from 2016 to 2021.¹⁰ Canadian internet access plan prices have recently trended below inflation, notably, reducing 1.7% year-over-year from June 2021 to June 2022, while headline inflation increased 8.1% during the same period, as the price of the majority of other consumer items increased.¹¹ These price trends demonstrate how facilities-based competition is delivering increasing value to consumers, while more Canadians rely on connectivity for essential services such as staying in touch with family and friends, consuming content, or working remotely. Notably, from 2014 to 2021, average download usage (GB) per wireline subscription per month increased 28.6% per annum (p.a.) and average wireless data usage (GB) per subscriber per month increased 25% p.a.¹² In addition to declining prices, the Canadian telecom sector also provided a range of low-cost programs that helped low-income families and seniors access affordable high-speed internet.

1 Government of Canada, 2021, "Quarterly economic and trade report"

2 PwC Analysis, Statistics Canada, S&P Capital IQ

3 Note: Capital expenditure total based on annual reports / S&P Capital IQ for TELUS, Rogers Communications, Shaw Communications, Bell Canada Enterprises, SaskTel & Vidéotron

4 oh lo PwC Analysis, S&P Capital IQ

5 Gov't of Canada, 2021, "3500 MHz Auction — Final Results"

6 PwC analysis, network quality is measured based on network speed, availability and video experience, PwC - understanding the cost and quality of networks across the G20

7 Opensignal Mobile Network Experience reports by country, 2021, PwC analysis, Note: Average download speeds - Canada (73 Mbps), Germany (43 Mbps), Japan (41 Mbps), U.S. (40 Mbps), France (36 Mbps), Italy (29 Mbps), the U.K. (27 Mbps), Australia (48 Mbps)

8 CRTC, 2022, "Communications Market Reports"

9 Gov't of Canada, 2022, "Renewing Canada's approach to Telecommunications Policy: Context for Action"

10 CRTC Annual Communications Monitoring Reports

11 Statistics Canada. Table 18-10-0004-13 Consumer Price Index by product group, monthly, percentage change, not seasonally adjusted, Canada, provinces, Whitehorse, Yellowknife and Iqaluit

12 CRTC Annual Communications Monitoring Reports

The connectivity provided by the telecom sector is at the centre of the digital economy, underpinning an ecosystem of use cases that are delivered across a technology stack of hardware, software and service, all of which rely on high-quality, reliable connectivity. Expansion of the digital economy through deploying enhanced connectivity (i.e., 5G) has the potential to contribute an incremental \$97B of GDP to Canada's economy by 2035 and support the delivery of a range of environmental and social benefits.¹³ Innovation is one of the key pillars of Canada's 2022 federal budget and in order to meet innovation and growth objectives, significant long-term investment will be needed by the telecom sector to deploy enhanced connectivity.

The telecom sector will continue to make a significant contribution to the prosperity of Canada through contributions to GDP and jobs, critical network infrastructure investments, and its important role in supporting technological advancement such as the deployment of critical climate technologies.



¹³ PwC Analysis, IHS Markit

Introduction

This report was prepared by PwC and commissioned by the Canadian Wireless Telecommunications Association (CWTA) as part of an annual series examining the economic impact of the telecom sector. This report sets out the economic impact of the telecom sector on the Canadian economy in 2021 and provides a view on the role that telecommunications has played and will continue to play in connecting Canadians, enabling use cases in the digital economy and helping Canada to meet environmental targets.

From March 2020, the COVID-19 pandemic highlighted the importance of high-quality, reliable connections, provided by the telecom sector. Throughout 2021, the telecom sector remained a critical player in supporting economic growth and connecting Canadians across the country, with real GDP in Canada increasing 4.6%. With significant GDP contributions, the sector is a key contributor to Canada having the 9th largest economy in the world, with a Debt-to-GDP ratio of only 130%, the lowest amongst G7 members.^{14, 15}

As Canada moves into a 'new-normal' post COVID-19, the telecom sector will be a key enabler of long-term prosperity for Canada, through network and innovation investments and the provision of connectivity that underpins Canada's innovation ecosystem. The sector's deployment of 5G is also expected to enable new use cases in the digital economy, such as smart farming and logistics that will bring a range of economic, environmental and social benefits.¹⁶



¹⁴ World Bank, 2021, "Gross domestic product 2021"

¹⁵ OECD, 2021, "General government debt"

¹⁶ PwC - 5G and the digital economy

1

The telecom sector is a significant contributor to Canadian GDP, jobs and investment

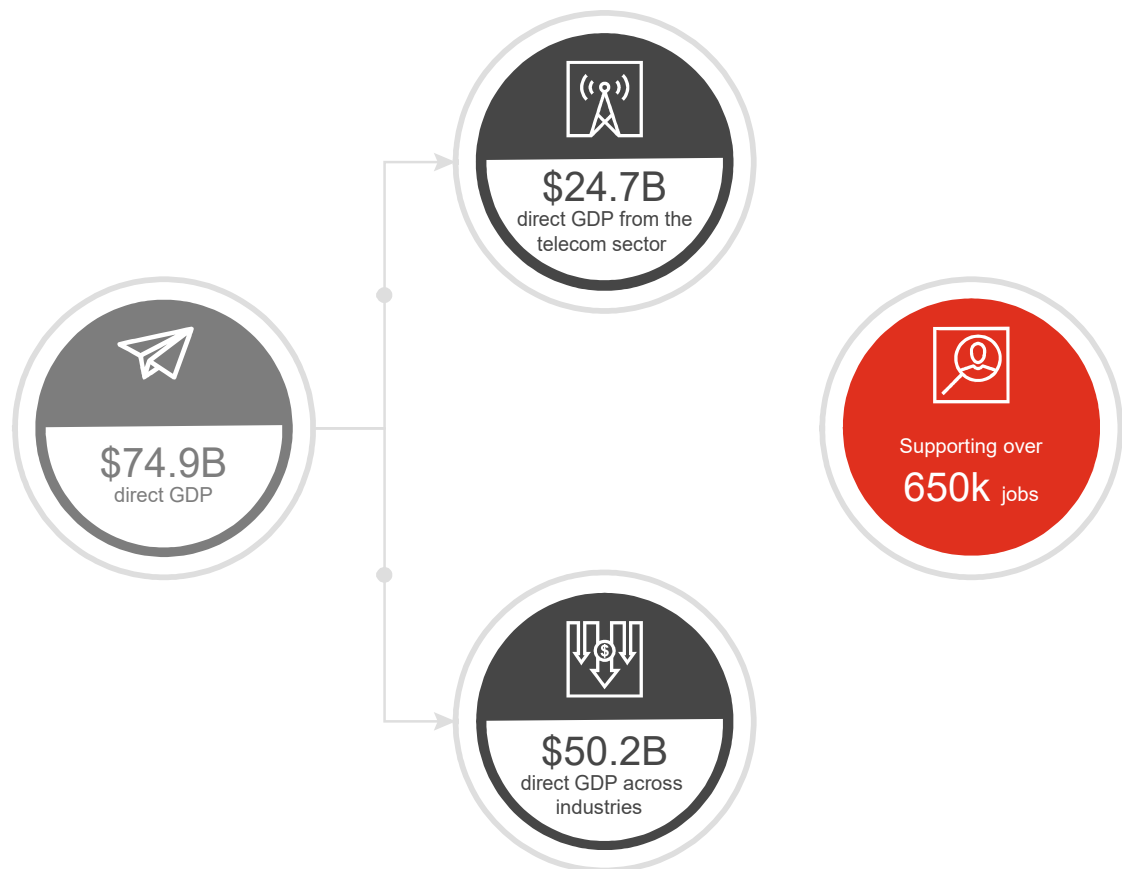
The telecom sector is a key contributor to Canadian GDP and jobs, contributing almost \$75B in direct GDP and supporting over 650K jobs in 2021. The Canadian telecom sector also makes large infrastructure and spectrum investments that help to connect Canadians with each other and the world.

The telecom sector is an important contributor to the Canadian economy

In 2021, the estimated direct GDP contribution and jobs supported by the telecom sector and the increased connectivity across other industries were up to \$74.9B and over 650,000 jobs, respectively.¹⁷ This includes \$24.7B in direct impact from the telecom sector's value chain¹⁸ and up to \$50.2B in direct impact due to the increase of sales and output of other industries through the addition of incremental wireless and wireline connections.

1. The Telecommunications Sector's Direct Economic Contribution in 2021

Exhibit 1: Estimated contribution to Canadian economy (2021) from the Canadian telecom sector – all values related to direct effects



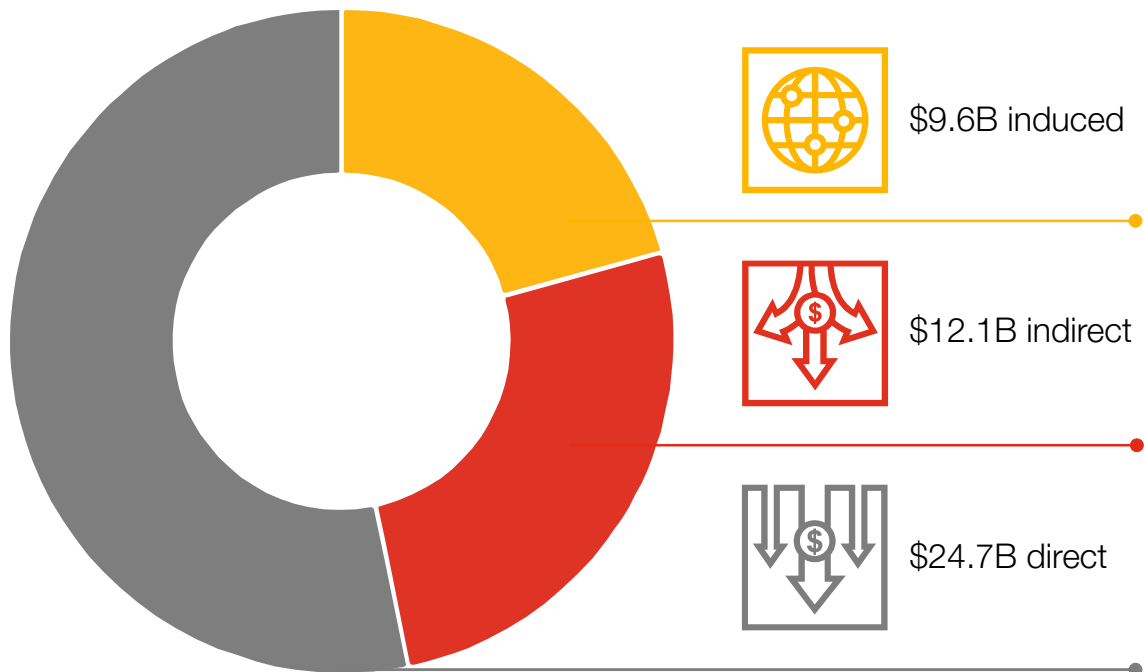
¹⁷ PwC Analysis, Statistics Canada, S&P Capital IQ

¹⁸ Note: The value chain for the telecommunications sector includes the communication service providers (CSPs) themselves (driving direct impact), the suppliers of CSPs (driving indirect economic impact), and the labour employed in the supply chain (driving induced economic impact)

The full economic impact of the telecom sector extends beyond the direct contribution of the value chain to include the indirect contributions of the immediate supply chain and the induced contribution from the increased spending of employees caused by the direct and indirect effects.¹⁹ In 2021, the Canadian telecom sector had a direct contribution of \$24.7B to GDP, representing the initial and immediate economic impact generated by the telecom sector's value chain, and supported almost 130,000 jobs. This direct impact resulted in increased business-to-business activity, creating indirect contributions of \$12.1B to GDP and supporting an additional 119,000 jobs. Both the direct and indirect effects created an increase in consumer spending and household income, which created induced contributions of \$9.6B to GDP and supported another 77,000 jobs.

2. Impacts from the Telecommunications Sector's Value Chain in 2021

Exhibit 2: Direct, Indirect and Induced contribution to Canadian GDP from the Canadian telecom sector (CA\$ Billions, 2021)²⁰



The Canadian telecom sector outpaces international peers in capital investments

Throughout the ongoing challenges caused by the COVID-19 pandemic, the telecom sector continued to make significant levels of investment in expanding and enhancing its digital infrastructure, with \$12.3B in capital expenditure made in 2021, in addition to \$11B in 2020.²¹ This investment represents an average of 19% of annual sector revenue (capital intensity).²² This level of capital intensity is higher than peers in other G7 countries and Australia where the average is 14%.²³ On a per subscriber basis, in 2021 Canada's telecom sector invested \$168 in capital expenditures per subscriber compared to a G7 and Australia average of \$87 per subscriber.^{24, 25}

¹⁹ PwC Analysis, Statistics Canada, S&P Capital IQ

²⁰ PwC Analysis, Statistics Canada, S&P Capital IQ

²¹ PwC Analysis, S&P Capital IQ

²² PwC Analysis, S&P Capital IQ

²³ Note: average capex to revenue ratio for all G7 countries & Australia 2021 excluding Canada

²⁴ PwC Analysis, S&P Capital IQ

²⁵ Note: average capex to subscriber ratio for all G7 countries & Australia 2021 excluding Canada

The Canadian telecom sector also continues to invest in the spectrum needed to keep pace with the increasing demand for wireless services and to deploy next-generation technologies such as 5G. Notably, Canadian companies paid approximately \$8.9B to acquire licences made available during the 3500 MHz spectrum auction.²⁶

The telecom sector's investment in spectrum demonstrates the sector's commitment to providing Canadian businesses and consumers with high-quality connectivity and has also provided the government of Canada with billions of dollars of revenue that can be reinvested. In 2022, the Government of Canada announced that the 3800 MHz spectrum band will be auctioned in 2023 and proposed that mmWave spectrum will be auctioned in 2024; both of which are expected to require billions of dollars in additional investment by the telecom sector.^{27, 28}



In focus – the Canadian telecom sector's capital investments in a global context

On a revenue basis, Canadian operators are smaller than their global peers in other G7 countries and Australia (AT&T's revenue is 9.7x Bell's revenue,²⁹ Canada's largest operator), with this revenue disparity largely due to Canada's relatively small population. On a cost basis, Canada's low population density³⁰ and large geographical footprint requires more infrastructure than peer countries (for example, compared to Japan, which has a highly concentrated population and a small land mass), yielding a relatively high build cost per subscriber (as outlined above). Therefore, Canadian operators maintain much higher capital intensity ratios than peers.

While some observers note that Canada's telecom sector maintains higher earnings before interest, taxes, depreciation and amortization (EBITDA) margins compared to many global peers, EBITDA does not consider the higher percentage of revenue that Canadian carriers must invest in capital expenditures. After adjusting for the differences in capital investment, Canadian operators' Free Cash Flow (FCF) ratio³¹ is in line with global peers.³²

The Canadian telecom sector contributed significantly to Canadian GDP in 2021 and more than six hundred and fifty thousand jobs. The sector's spectrum and capital infrastructure investments exceed those of international peers and help Canada to keep pace with increasing demand and deployment of next-generation networks and technologies.

²⁶ Gov't of Canada, 2021, "3500 MHz Auction — Final Results"

²⁷ Gov't of Canada - 3800Mhz Spectrum

²⁸ Gov't of Canada - mmWave proposal

²⁹ Note: Average annual revenue 2019-2021, PwC analysis

³⁰ World Data - The largest countries by area

³¹ Note: Bell, Rogers and Telus used for this analysis. Free cash flow is the cash a company generates after taking into consideration cash outflows that support its operations and maintain its capital asset, in other words the cash left over after a company pays for its operating expenses and capital expenditures (CapEx)

³² PwC Analysis, Public available Annual reports

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The telecom sector's investments deliver positive outcomes for Canadians

The Canadian telecom sector's large investments create high-quality networks that provide strong coverage across Canada. These investments are being made as the price of mobile plans are declining, and the importance of connectivity for daily life increases.

Wireline and wireless networks provide strong coverage for Canada

Wireless

The Canadian telecom sector provides Canada with 99.7% mobile wireless network coverage. This includes 98.5% coverage of rural areas, 90.5% of First Nations reserve areas and 88.5% of major roads and highways.³³ The Canadian Radio-television and Telecommunications Commission (CRTC) estimates that the telecom sector is on track to deliver 100% mobile coverage in homes, businesses and major transportation roads by 2026.³⁴

The Canadian telecom sector is also deploying 5G in major cities across Canada.³⁵ Opensignal's 2022 global benchmarking ranked all of Canada's national operators as "Global High Performers" for 5G reach³⁶ with customers on average connecting to a 5G network in a given location approximately half of the time. South Korea, Taiwan and Saudi Arabia are the only other countries that have three network operators with as high a ranking. Users' 5G experience is expected to further improve as all major operators have committed to increasing coverage through deploying newly acquired spectrum.³⁷

In addition to broad coverage, wireless users in Canada experience average download speeds that are significantly faster than the average speeds in other G7 countries and Australia, including over 80% faster than the average speed in the U.S.³⁸ Based on a mobile wireless network quality index that considers speed, availability and video experience (see Exhibit 3), Canada ranked above G7 peers and Australia due to relatively high download speeds and a strong video experience score.³⁹

33 CRTC, CRTC Communications Market Reports. Note: Measured by the percentage of homes, business and major transportation roads that have combined coverage of HSPA+, LTE, LTE-A and 5G

34 CRTC, CRTC Communications Market Reports

35 IT world, 2022

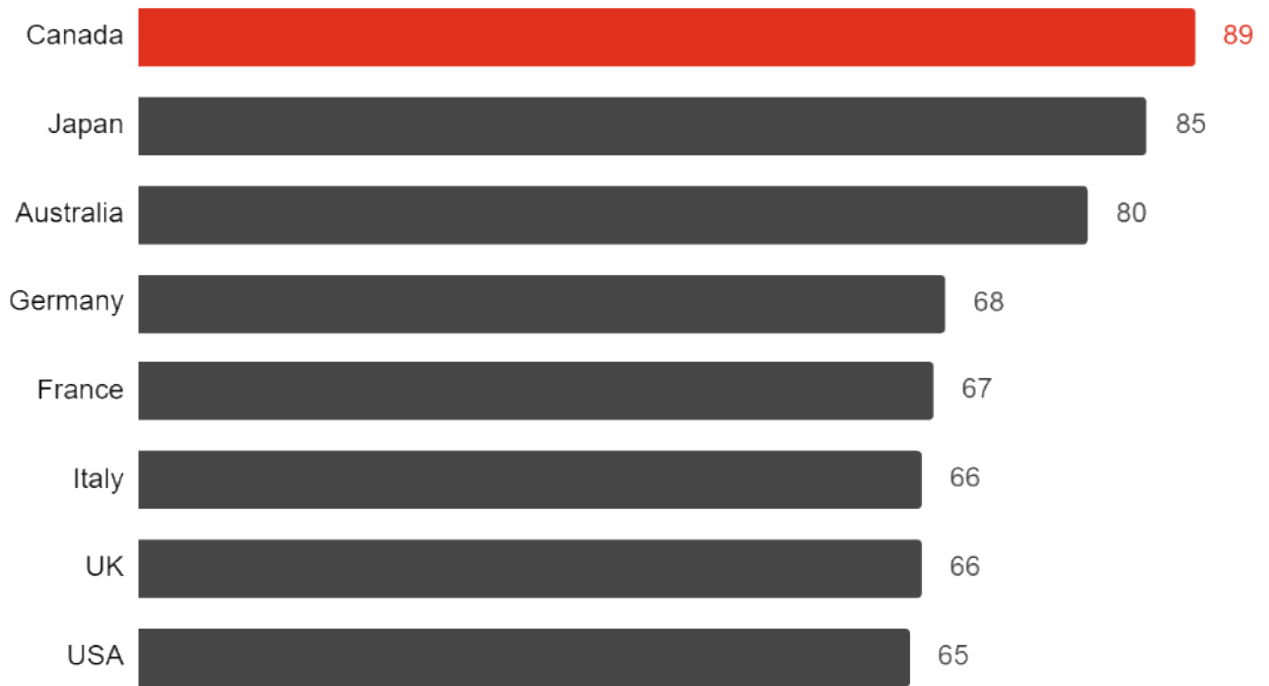
36 Opensignal, 5G Global Mobile Network Experience Awards 2022

37 Opensignal, Benchmarking the Global 5G Experience

38 Opensignal Mobile Network Experience reports by country, 2021, PwC analysis, Note: Average download speeds - Canada (73 Mbps), Germany (43 Mbps), Japan (41 Mbps), U.S.A. (40 Mbps), France (36 Mbps), Italy (29 Mbps), the U.K. (27 Mbps), Australia (48 Mbps)

39 Opensignal, PwC analysis

Exhibit 3: PwC quality index for Canada and G7 peers + Australia (network speed, availability and video experience) (out of 100, 2021)



Wireline

The sector is successfully delivering access to high-speed internet, in line with the federal government’s goal for 98% of Canadians to have access to high-speed internet of at least 50 megabits per second (Mbps) download and 10 Mbps upload speeds by 2026, and 100% of Canadians by 2030.⁴⁰ As of the end of 2020, investments made by the telecom sector increased access to 50/10 Mbps internet speeds and unlimited data to 89.7% of Canadian households.⁴¹

Comparing high-speed internet access in Canada to other countries using government-established standards is difficult given different definitions of high-speed internet used in each country. For example, while the Government of Canada uses 50/10 Mbps internet speed as its primary target for high-speed internet, the UK defines “superfast” internet as 30 Mbps download speed,⁴² while the U.S. standard is currently set at 25 Mbps download and 3 Mbps upload.⁴³ However, comparing technologies and available speeds, Canada, despite its large geographic footprint and low population density, compares favourably to its international peers. For example, the household coverage of full fibre networks in Canada in 2021 (49%) was ahead of several G7 peers, notably the U.S. (42%), Australia (16%), U.K. (18%), Germany (11%) and Italy (34%) (Exhibit 4).⁴⁴ When factoring in cable networks, coverage of the faster speeds of 100 Mbps and 1 Gbps are available to 76% and 51% of homes in EU countries, compared to 87% and 76% of homes in Canada.⁴⁵

40 ISED - Progress toward universal access to high-speed Internet

41 CRTC, 2022, “Quick facts”

42 Fair Internet Report, 2022, “UK Broadband Definition”

43 Washington Post, 2015, “The FCC has set a new, faster definition for broadband”

44 Gov’t of Canada, 2022, “Renewing Canada’s approach to Telecommunications Policy: Context for Action”

45 Gov’t of Canada, 2022, “Renewing Canada’s approach to Telecommunications Policy: Context for Action”

The telecom sector provides access to high-speed internet to rural and remote communities both independently and in partnership with various levels of government, the combination of which is making progress in closing the rural/urban digital divide. As of 2020, the number of rural households that had access to 50/10 Mbps internet speeds with unlimited data rose by 46% since 2017 (54.4% vs 37.2%).⁴⁶ The sector's delivery of 50/10 connectivity helps to close the rural/urban divide, supporting stronger rural and Indigenous communities through enabling remote working, encouraging business investment, providing increased access to health-care and social assistance, increasing access to online education and supporting the delivery of online programs that increase social inclusion and wellbeing.⁴⁷

In 2021, in addition to the projects delivered by telecom providers themselves, the telecom sector continued to partner with various levels of government to expand and enhance high-speed internet services. Notable partnerships include the following:

- The Government of Canada, the Government of Quebec and internet service providers (ISPs), Vidéotron, Cogeco, Bell, Xplornet, Sogetel and TELUS, partnered to launch the extensive Canada-Quebec Operation High Speed, to connect nearly 150,000 homes in Quebec to high-speed internet by September 2022.⁴⁸
- The Government of Canada, the Government of Ontario and ISPs including Bell, Rogers, Bragg Communications (Eastlink) and Xplornet partnered as part of the Ontario government's "Ontario Connects" program to connect every region of Ontario with high-speed internet by 2025.⁴⁹
- Rogers partnered with Eastern Ontario Regional Network and the government to bring 99% connectivity to Eastern Ontario communities by 2025. The joint public-private sector project required a total investment of \$300M to build the local infrastructure, with Rogers funding half of the investment.⁵⁰
- SaskTel announced that it would double its investment in its Rural Fibre Initiative, bringing fibre-optic broadband to 24 more rural communities.⁵¹
- NorthwesTel continued to make investments as part of its three-year "Every Community" project in which NorthwesTel has partnered with the CRTC Broadband Fund, a fund financed by the telecom sector, to bring high-speed unlimited internet to every Yukon and Northwest Territory community.⁵²

46 CRTC Annual Communications Monitoring Reports. As of 2020, rural coverage for 50 Mbps+ download was 74.6% (an increase of 90% from 2017 coverage of 39.2%)

47 United Nations 2021 World Social Report Reconsidering Rural Development

48 Gov't of Canada, 2021, "Unprecedented agreement to connect nearly 150,000 Quebecers to high-speed Internet"

49 Infrastructure Ontario, "Ontario Connects"

50 Rogers - \$300M Partnership to Expand Wireless Connectivity and Bring Choice to Eastern Ontario

51 Sasktel, 2021, "SaskTel doubling its investment to bring advanced fibre optic broadband infrastructure to rural communities across Saskatchewan"

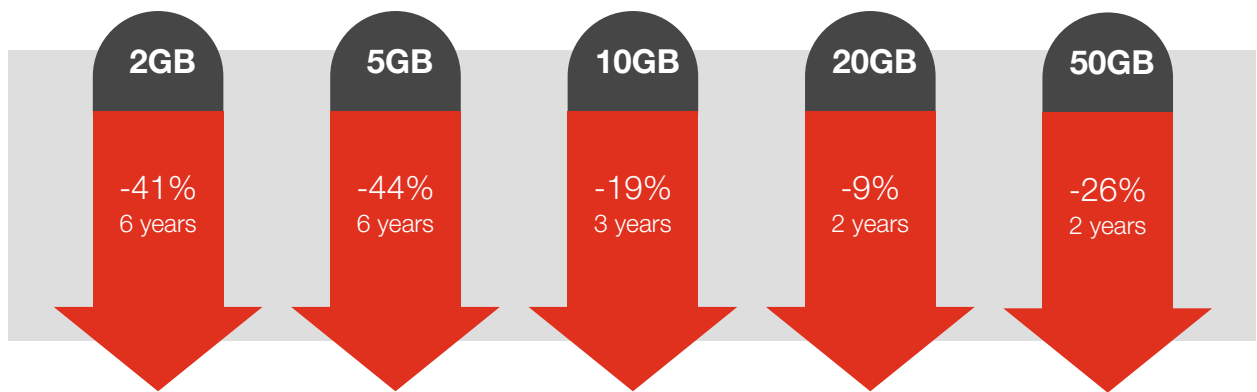
52 NorthwesTel, 2020, "Every Community Project"

Cellular and internet prices have decreased, as data usage has increased, and more Canadians rely on connectivity services

Wireless

Average consumer prices of mobile plans across a range of data sizes have decreased in Canada, as facilities-based competition has delivered increasing value to customers. The price of plans with 2GB and 5GB of data declined by 41% and 44% respectively from 2016 to 2021, 10GB plans declined by 19% from 2019 to 2021 and 20GB and 50GB plans declined by 9% and 26% respectively from 2020 to 2021 (Exhibit 5).⁵³ These declines saw the telecom sector achieving the Government of Canada's desire for a 25% reduction in the price of mid-range wireless plans ahead of schedule.^{54, 55}

Exhibit 4: Price decreases of mobile plans in Canada by plan type (2016 to 2021)



Additionally, according to Statistics Canada, from 2017 to 2021, cellular service prices decreased 11% per annum (p.a.), while other product groups such as shelter and transportation prices increased at 3% and 4% p.a. respectively.⁵⁶ This downward trend has continued into 2022, with the year-over-year increases in Consumer Price Index (CPI) for “All Items” hitting a 39-year high at an 8.1% increase in June, while comparatively the CPI for “Cellular Services” decreased 0.3% over the same period.⁵⁷

⁵³ CRTC Annual Communications Monitoring Reports

⁵⁴ ISED, 2022, “Government of Canada delivers on commitment to reduce cell phone wireless plans by 25%”

⁵⁵ Note: Benchmark based on company websites prices from early 2020 for three wireless plans offering 2 GB, 4 GB and 6 GB of data respectively

⁵⁶ Statistics Canada Consumer Price Index Table 18-10-0004-01, PwC Analysis

⁵⁷ Statistics Canada Consumer Price Index, 2022

Wireline

Canadian internet access plan prices are also trending below inflation, decreasing 1.7% year-over-year from June 2021 to June 2022.⁵⁸ This price decrease occurred in conjunction with the private sector expanding low-cost internet access programs for Canadians with low incomes.⁵⁹ These programs offer \$20/month high-speed internet services (50/10 Mbps), helping to connect low-income families and seniors to affordable high-speed internet.⁶⁰ Some operators also provide other plans at lower cost and/or with different plan attributes.



Price declines, higher speeds and larger data allotments, including unlimited data plans, are occurring as connectivity is increasingly essential to daily life, with more Canadians relying on connectivity services to stay in touch with family and friends, consume content, or work while on the move. This increased importance can be observed by the increasing demand for wireline and wireless services. Wireless subscriptions increased at an average of 2.2% p.a. from 2014 to 2021, reaching 33.4M at the end of 2021 and wireline subscriptions increased at an average of 2.6% p.a. from 2014 to 2021, reaching 12.1M subscriptions at the end of 2021.⁶¹ Over the same period, average download usage (GB) by wireline subscription per month increased 28.6% p.a. and average wireless data usage (GB) per subscriber per month increased 25% p.a.⁶²

⁵⁸ Statistics Canada. Table 18-10-0004-13 Consumer Price Index by product group

⁵⁹ ISED - Connecting Families

⁶⁰ ISED - Connecting Families. This initiative was initiated by the telecom sector without any government subsidy

⁶¹ CRTC-Statistics Canada Quarterly Survey, Note: Change in methodology by CRTC resulted in drop in subscribers at the beginning of 2021 ("starting in 2021 mobile phone subscriptions exclude subscriptions to 'mobile broadband' and 'other plans for mobile connected devices"). Had the change in methodology not been made, based on the trend prior to the change the 2021 total would be closer to ~37.6M subscribers

⁶² CRTC Annual Communications Monitoring Reports

The telecom sector provides high-quality middle-class jobs and delivers a range of community initiatives

The telecom sector also provided over 120,000 well-paying, high-quality, middle-class jobs in 2021,⁶³ spending over \$12B in employee salaries and benefits in 2021.⁶⁴ These employees further contribute to the Canadian economy by exercising their purchasing power and through the payment of taxes.

In addition to the direct benefits provided to Canada's economy, the telecom sector also made approximately \$250M in annual charitable donations⁶⁵ in 2021 across a range of community initiatives that make a positive impact. Notable donations include the following:



Rogers' "Group of Funds" initiative, which provided approximately \$23M to support Canadian content creators and artists in the BIPOC community.⁶⁶



Bell's "Let's Talk Post-Secondary Fund", which awarded approximately \$3M in grants to post-secondary institutions in light of mental health support services and initiatives, building on the "Let's Talk Community Fund", which has provided approximately \$15M across 888 national mental health services and support organizations since 2011.⁶⁷



Quebecor (Vidéotron) donated \$1M to the Autiste & Majeur Foundation to help fund the development of day centres for people with autism aged 21 and over across Québec.⁶⁸



Shaw donated \$1M to Alberta-based children's charities through the **Shaw Charity Classic**, which has raised over \$61M for child and youth charities over the past eight years.⁶⁹

More Canadians are relying on connectivity services to stay in touch with family and friends, consume content, or work while on the move. The price of these services has declined in an inflationary environment, while the telecom sector continues to deliver a range of low-cost programs that provide affordable high-speed internet.

⁶³ Public available Annual reports

⁶⁴ Public available Annual reports

⁶⁵ PwC Analysis, Public ESG Reports

⁶⁶ Rogers, 2021, "Connecting Canadians 2021 Environmental, Social and Governance Report"

⁶⁷ Bell, 2021, "Bell for Better 2021 Corporate Responsibility Report"

⁶⁸ Quebecor, 2021, "Quebecor partners with Autiste & Majeur Foundation to support development of day centres across Québec"

⁶⁹ Shaw, 2021, "Shaw donates \$1 million to support over 230 children and youth charities"

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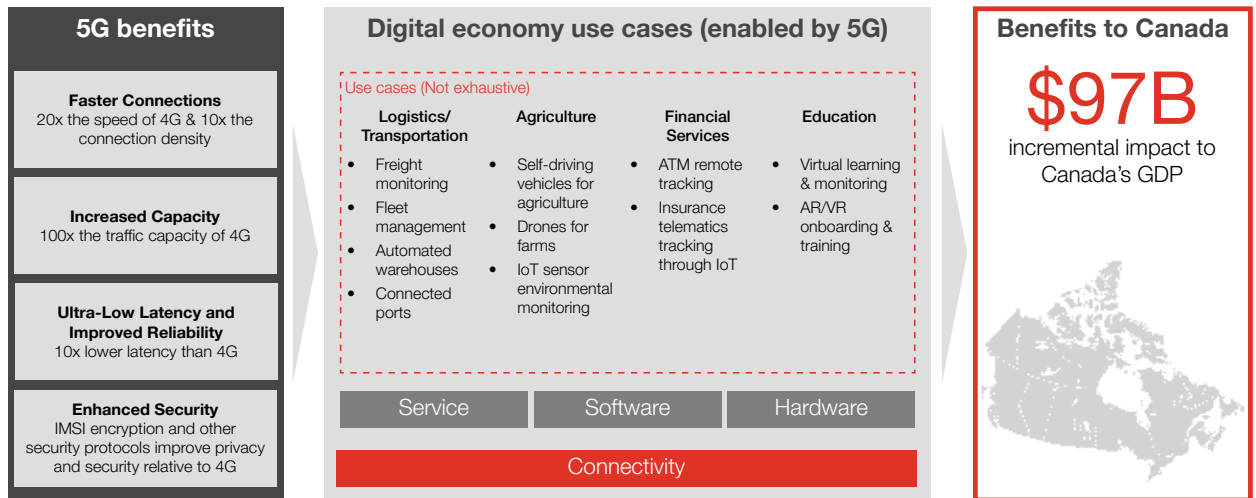
The telecom sector is the centre of the digital economy and will continue to enable Canada’s economic growth and high-tech success

The telecom sector’s provision of connectivity is important for the development of the digital economy. The deployment of enhanced connectivity such as 5G will enable a range of use cases in the digital economy, providing economic, environmental and social benefits to all of Canada.

Connectivity is at the centre of the digital economy

The connectivity provided by the telecom sector powers the digital economy, which has the potential to revolutionize existing industries and create new ones. Enhanced connectivity such as 5G supports use cases in the digital economy, as a larger number of devices can connect at the same time enabling the capture and transmission of large amounts of data in real-time.⁷⁰ This expansion of use cases in the digital economy has the potential to contribute an incremental \$97B to Canada’s GDP by 2035 (Exhibit 6), with notable impacts on industries such as manufacturing, mining and agriculture.⁷¹

Exhibit 5: Benefits of 5G, use cases enabled and incremental impact to Canadian GDP



⁷⁰ Cisco, 2020, "Annual Internet Report"
⁷¹ PwC Analysis, IHS Markit

Manufacturing

- **Autonomic operations** allow manufacturing plants to optimize sequencing and resources to react in real time to changes such as fluctuations in supply and demand or equipment breakdowns. This type of operation goes beyond current automation capabilities (e.g., robot arms in an assembly line completing tasks in a predetermined sequence) and creates systems that are capable of real-time decision making and flexibility.⁷²
- **Digital twins** allow plant operators to comprehensively track and model plant operations, which enables improved decision making, leading to better plant efficiency (i.e., greater output, reduced waste). For example, digital twins can be used to conduct predictive maintenance, which can reduce downtime, and to optimize operating conditions to improve the economics of a factory.⁷³

Mining and Oil & Gas

- **Self-driving trucks** for material hauling can improve efficiency by 10 to 30%^{74, 75} by optimizing driving patterns to reduce fuel consumption, engine wear and downtime.⁷⁶
- **Automated drill rigs** can bring efficiencies of up to 40% to the current process by increasing machine operating hours, allowing operators to either increase drilling or reduce the number of machines required. This can also improve safety by eliminating the movement of staff through dangerous areas.⁷⁷

Agriculture

- **5G-enabled precision agriculture (PA)** allows farmers to optimize their input consumption (e.g., water, fertilizer), monitor equipment and improve yields. The use of PA soil sensors allows for automated irrigation of fields and can reduce the water usage on a farm by as much as 30%.⁷⁸

Enhanced connectivity supports Canada's innovation priorities

Innovation is one of the three key pillars of Canada's federal budget for 2022,⁷⁹ with a particular focus on translating investment into output. Canada has a relatively high innovation input score, but a much lower innovation output score, resulting in the World Intellectual Property Organization (WIPO) deeming Canada to be one of several high-income economies that has "inefficient" innovation.⁸⁰ To improve innovation output, Canada can seek to leverage a number of notable foundational technologies of the future, where the connectivity provided by the telecom sector has helped Canada to develop notable expertise.

72 Menascé et al. 2015. "Autonomic smart manufacturing". Journal of Decision Systems

73 Hartmann and Van der Auweraer. 2020. "Digital Twins". Siemens

74 Accenture. 2020. "Mined Over Matter: The Not-Too-Distant Future of Autonomous Operations"

75 Ericsson. 2018. "A case study on automation in mining"

76 Cisco. 2020. "Wireless Networks enabling autonomous vehicles for underground mines"

77 Ericsson. 2018. "A case study on automation in mining"

78 CIO, 2020, "Using 5G to revolutionise farming"

79 Budget 2022

80 WIPO, 2021, "Global Innovation Index 2021"

Digital health	Energy and industry optimization	Connected and autonomous vehicles (CAVs)	Artificial intelligence	Quantum computing
<ul style="list-style-type: none"> Adoption of digital health and virtual care in Canada jumped from 10%-20% usage in 2019 to 40% in 2021⁸¹ Through connectivity, real-time health is enabled, allowing personalized care and improves efficiency in the health-care sector⁸² 	<ul style="list-style-type: none"> Canadians are scaling their utility bills down through efficient use of energy with smart homes and buildings⁸³ Businesses are optimizing industry potential through automation, maximizing output yield while reducing carbon footprint and water waste⁸⁴ 	<ul style="list-style-type: none"> A high level of collaboration between Canada's leading universities, a strong automotive industry and the tech sector (notably in AI) have allowed Canada to be an important player in the development of CAVs⁸⁵ 	<ul style="list-style-type: none"> Toronto has the largest concentration of AI start-ups in the world with Canada ranking 4th on the Global AI Index⁸⁶ Canada ranks 1st in receiving government support for AI advancements (spending commitments and overall national strategies)⁸⁷ 	<ul style="list-style-type: none"> Canada ranked 1st in quantum technology expenditure per capita in comparison to its G7 peers, fostering a strong ecosystem of researchers, public funding and incubators⁸⁸ Canada boasts leading quantum computing companies such as D-wave and Xanadu

The Canadian telecom sector contributes significantly to research and development (R&D). Notably, Bell, Rogers and TELUS are among the largest private sector spenders on R&D in Canada, with each spending around \$500M in 2019 and 2020. These investments support initiatives such as university research in 5G, AI and cybersecurity, including development projects to explore new made-in-Canada 5G capabilities.^{89, 90, 91}

Investing in digital infrastructure is important for Canada achieving environmental and social objectives

The introduction of technologies enabled by enhanced connectivity can help to mitigate environmental concerns and support Canada in achieving its global environmental commitments such as the UN sustainable development goals.⁹² According to Ericsson research, Information and Communication Technology (ICT) could help reduce global carbon emissions by up to 15% by 2030.⁹³ For example, using the low latency and faster speeds of 5G and other digital cellular technologies, organizations can connect and manage remote assets, helping to lower carbon emissions, reduce costs and improve outputs.⁹⁴ Enhanced connectivity also supports Canada's rural communities, education platforms and health-care system through underpinning new, innovative technologies, and connecting Canadians across communities with strong wireless and wireline access.

81 Canadian Medical Association, 2022, "Virtual care in Canada progress and potential"

82 PwC - 5G in Healthcare

83 Enercare, 2022, "8 Ways Your Smart Home Can Save Energy"

84 PwC - 5G and the digital economy

85 Canadian Vehicle Manufacturers' Association

86 Tortoise Intelligence, 2021, "The Global AI Index"

87 Tortoise Intelligence, 2021, "The Global AI Index"

88 IBM, 2021, "Driving Canada's Industrial & Academic Eminence towards a National Quantum Strategy"

89 Rogers, 2021, "Rogers and UBC renew 5G research partnership through 2025"

90 BCE annual report, 2021

91 Research Infosource, 2021, "Canada's Top 100 Corporate R&D Spenders 2021"

92 United Nations 2030 Agenda for Sustainable Development

93 Ericsson "How 5G and connectivity can help support climate action"

94 MIT & Ericsson, 2021, "Decarbonizing industries with connectivity & 5G"

Environmental	Social
<p>Reduced energy use: Enhanced connectivity allows for greater data capture and sharing, which can be leveraged to improve decision making with regard to energy consumption. Example use cases include smart buildings and homes enabled by 5G, which allows for stable and fast connection of multiple devices, all working to improve comfort while optimizing energy efficiency.⁹⁵</p> <p>Efficient water use: Enhanced connectivity enabled sensors can relay information and automate decision making to improve water consumption and quality. Examples include deploying smart water sensors as part of smart cities projects, which can improve water conservation practices through consumption-based feedback for customers.⁹⁶ Sensors can also be used to monitor real time water quality, allowing for cities to quickly mitigate quality issues.⁹⁷</p> <p>Reduced emissions: Enhanced connectivity enabled smart analytics and automation can be leveraged to automate emissions monitoring and optimize treatment strategies. For example, smart manufacturing processes that rely on automation and condition-based maintenance can reduce emissions through the prevention of unnecessary maintenance activities, and in turn reduce fuel consumption.</p>	<p>Advancing rural and Indigenous communities: The deployment of broadband to rural communities supports economic development in sectors that are key to rural economies. Using low-band 5G connectivity can be a lower cost alternative to bridging the rural-urban connectivity gap by providing Fixed Wireless Access (FWA). Improving connectivity and economic competitiveness to regional and underserved communities can support in creating high-tech, high-skill jobs in these areas.</p> <p>Improving educational opportunities: By providing FWA to schools and homes where wired broadband connections are unfeasible, 5G will provide better connections for students and teachers for online learning. 5G's low latency and increased capacity also allow for more immersive teaching tools to be used such as VR and AR headsets.⁹⁸</p> <p>Providing increased access to health care: Enhanced connectivity can help support health-care systems to deliver improved patient outcomes while reducing overall system costs. Examples include remote health monitoring, which can reduce the length and costs of hospitalizations through earlier intervention, and AI-enabled remote diagnostics, which can reduce resource intensity by freeing up clinician time and enable better predictive care.</p>

Continued investment is needed to achieve innovation and growth objectives

The enhanced connectivity delivered by the telecom sector is an important enabler of the digital economy, which offers the promise of a range of economic, environmental and social benefits to Canada. In order to deliver 5G connectivity, the Canadian telecom sector needs to maintain investment and overcome a number of challenges, notably:

- The increased cost of 5G:** The cost of 5G is significantly higher than previous generations of connectivity. In order to enable use cases in the digital economy, 5G networks need to reach near-ubiquitous coverage throughout both rural and urban areas. Consequently, 5G will cost the telecom sector more to install and operate than previous generations, with the total cost of ownership (TCO) estimated to be up to 71% higher relative to 4G networks⁹⁹ and capital expenditure to be ~100-300% higher in 2025/2027 relative to 2018.¹⁰⁰

⁹⁵ Intel

⁹⁶ Nature, 2021, "Long-term water conservation is fostered by smart meter-based feedback and digital user engagement"

⁹⁷ Verizon, 2021, "Technology & Water: How 5G and IoT Can Update Our Water Infrastructure"

⁹⁸ University of Toronto, 2021, "Virtual Field Trips and General VR Content Apps"

⁹⁹ GSMA, 2019, "5G-era Mobile Network Cost Evolution"

¹⁰⁰ GSMA, 2020, "Realising 5G's full potential: Setting policies for success"

- **Canada's dispersed geography:** Canada's dispersed geography, weather and challenging landscape contribute to the challenge of rolling out and maintaining telecommunications networks. This is evidenced by the significantly higher ratio of capital expenditure to revenue for Canadian telecoms relative to their global peers (as discussed in section 1).¹⁰¹
- **Market imbalances in the digital economy:** Value in the digital economy accrues to companies that use software, hardware and services to provide 5G-enabled solutions, rather than those that provide connectivity. This growing imbalance in value is a global concern, which Canada is not immune to.

These challenges reinforce the need for a healthy telecommunications sector that is capable of funding the expansion and enhancement of telecom networks across Canada, including 5G, and delivering strong national coverage to both businesses and consumers.

The telecom sector is a key contributor to the advancement of Canadian societal, environmental and innovation efforts, notably through the deployment of 5G connectivity. In order to reach growth objectives, Canada will require continued long-term investment from the telecom sector.

Conclusion

The telecom sector plays a significant role in Canada's economy contributing almost \$75 billion in GDP output and supporting over 650K jobs in 2021. The sector played a critical part of the economic and social recovery post COVID-19, supporting economic growth as well as underpinning Canada's innovation ecosystem. Looking forward, the Canadian telecom sector will continue to contribute significantly to Canadian GDP and jobs, as well as impact revenues across industries—notably through the deployment of 5G.

The telecom sector's ongoing investments in critical network infrastructure, including 5G and spectrum will provide increased coverage, high-quality networks across Canada and support the growth of the digital economy. The Canadian telecom sector has an important role to play in the advancement of technology, notably supporting the deployment of climate technology that is required for Canada to meet future sustainability targets, such as the 2030 UN Sustainable Development Goals.

The telecom sector is and will continue to be a key contributor to prosperity and innovation in Canada, connecting Canadians across the country through provision of high-quality wireline and wireless networks.

¹⁰¹ PwC. 2020. "The importance of a healthy telecommunications industry to Canada's high tech success"

Methodology

1 General Canadian telecom sector calculations

The telecom sector as defined in this report and used in the economic modelling refers to network operators supplying wireless and wireline connectivity services—excluding television video services and infrastructure, as well as satellite connectivity and other supporting sub-industries. The majority of figures in this report combine data for the major providers, which represent over 99% of the sector's revenues: TELUS, Rogers Communications, Shaw Communications, Bell Canada Enterprises, SaskTel and Vidéotron. Where applicable, analyses were performed using operator figures from the calendar year January 1, 2020 to December 31, 2020.¹⁰² All dollar figures are represented in Canadian dollars using the Bank of Canada exchange rate to the relevant country's currency.

2 Economic analysis

The economic impact highlighted in this study represents the telecom sector's contribution to the Canadian economy through its value chain as well as the impact on additional industries that could drive greater sales and increase output due to new wireless and wireline connections.¹⁰³ Multipliers used are the 2018 Statistics Canada multipliers for the Information and Culture industry at the national level. In order to show the impact of new connections on other industries, the estimated relationship between increases in connections of mobile and fixed broadband was applied to industry output/sales.¹⁰⁴

3 Incremental impact of 5G analysis

To quantify the potential future impact of 5G on Canadian GDP, IHS Markit projects an industry by industry percentage of sales enabled by 5G in 2035. Starting in 2022, leveraging these IHS growth projections, we estimate, on an industry by industry basis (per Statistics Canada NAICS), the incremental impact of the deployment of 5G-enabled technologies in Canada by 2035.



102 Note: Excluding Shaw and SaskTel, which report figures on non-calendar years, a pro-rated method was taken to approximate figures based on a calendar year.

103 Note: Media revenue and operating expenditures for Rogers and Bell have been omitted, TELUS reporting segments changed from 2020 to 2021 - digital customer experience segment has been omitted but may have been included in previous year

104 Note: Statistics Canada industry NAICS GDP, 2021



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