



CREATING DIGITAL OPPORTUNITY FOR CANADA

David A. Wolfe | Innovation Policy Lab

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The Brookfield Institute for Innovation + Entrepreneurship (BII+E) is an independent and nonpartisan think-tank, housed within Ryerson University that is dedicated to understanding the opportunities and risks in Canada's shift to an innovation-driven economy. BII+E supports this mission by: undertaking insightful research and analysis; testing, piloting and prototyping ideas; and engaging Canadians through policy innovation approaches with the goal of building a innovation-driven economy that works for everyone.

Creating Digital Opportunity is a national research partnership funded by the Social Sciences and Humanities Research Council and based at the Innovation Policy Lab in the Munk School of Global Affairs. The mission of the project is to identify strengths in current and emerging digital sectors, by examining the place of Canadian corporations, products and services in the global economy. The project is also investigating the extent to which digital technologies are being adopted and diffused across a wide range of other sectors—from advanced manufacturing to natural resources and business services – which are crucial for the future competitiveness of the Canadian economy. The project addresses the question whether we are taking full advantage of the opportunities on offer.

The Innovation Policy Lab (IPL) at the Munk School of Global Affairs is committed to applying novel methods and disciplines to the study and teaching of innovation and its impact on economic opportunity and society. The IPL focuses on core questions in a number of areas including innovation and growth, innovation and inequality, globalization and innovation, social innovation, new technologies and their impact on society, innovation in traditional industries, and arts and innovation. Since our aim is also to effect change, we pay particular attention to the role of public policy in nurturing innovation, while at the same time enhancing its positive impacts on society and limiting its negative consequences.

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PART ONE

TIME FOR A REBOOT

FROM HARDWARE TO SOFTWARE

THE PACE OF THE DIGITAL REVOLUTION is accelerating. A critical feature of this revolution — and one propelling the acceleration — is the rapid spread of mobile devices, cloud computing and data analytics, which has shifted the focus of innovation from hardware to software and data.

From the early days of analog computers, cellular phones and other pioneering devices, the focus has turned to less tangible and visible — but no less ground-breaking — software-based technologies that drive many of today's commercial success stories. The leading edges of the digital economy are now platform-based business models, digital networks, cloud computing, artificial intelligence, massive data sets, social media algorithms and smart phone apps, among others.

This shift has laid the groundwork for faster, smaller, cheaper and more accessible products and services, which are having a profound impact on the global economy. They are altering the basis of competition by lowering barriers to entry in an array of industries, thereby spawning a new generation of platform firms, far nimbler than the giants that have long dominated these sectors.

It is no longer possible to underestimate the importance of the digital economy. Not since the introduction of electricity have we seen an interconnected set of technologies with such potential to disrupt established industrial sectors and economic patterns and, in doing so, to generate new opportunities for future generations.

The rise of platform firms is creating new opportunities for entrepreneurial start-ups to introduce dynamic new services that turn conventional business models on their heads, and are forcing established companies to follow suit. The result is that platform technologies and the digital networks that support them have become essential tools for businesses across the economy. Most important, the pace of innovation is accelerating, dramatically compressing the time it takes to disrupt established markets. As leading commentators have put it, we are living in an age of exponential growth where digital innovation constantly creates new economic opportunities, but also brings significant disruption.

The implications for Canada are profound. Internet-based services located thousands of miles away can now plug into our domestic market in seconds. Upstart firms in China, like dx.com, everbuying.net, lightinthebox.com, tomtop.com, milanoo.com, chinavasion.com and focalprice.com, now sell more than \$2 billion worth of goods a year in global markets. The same digital channels create an opening for Canadian firms, who are starting to scale up and connect to this global market of 7.5 billion people. What we sell in the future however, may be fewer hard goods, and more intelligent software with a myriad of applications in business and consumer markets.

The growing emphasis on software-based products and digital channels also means that we are shifting from a world shaped by economies of scale, which are quite sticky and capital-intensive, to a more flexible environment where economies of scope based on platforms and networks dominate. This trend offers both risks and rewards for open trade-oriented economies like Canada, where the success of domestic firms in the digital age will depend on their ability to develop and scale up products that can sell into these global markets.

Canada's brand in the unfolding digital revolution will be based on innovation and trust. Our challenge is to develop products and services that have broad applications and standards applicable to mass markets beyond our borders. Examples abound of countries that have shown it is possible to specialize in specific market niches of the digital economy and drive a substantial share of the global market to their shores.

Even as we marvel at these fast-expanding horizons and adjust to the challenges they pose, we are learning that success in the digital economy also hinges on the strength of innovation ecosystems closer to home. Many of the world's most creative digital industries have sprung from the convergence of global connections and local networks within a single city or region.

Done right, the combination of global and local, formal and informal, produces a continuous stream of new ideas, attracts fresh talent, and creates value through new business models. The linkages complement and nourish each other, reinforcing the growth of an industry, both locally and globally. The Toronto-Waterloo innovation corridor and Montreal's flourishing video-game cluster provide several examples of how Canada is reaping the benefits of this interaction.

As Canada seeks to harness the unfolding digital revolution as a driver of future growth, three questions stand out:

- What are our competitive strengths in digital technology?
- Given those strengths, where do the best opportunities lie to grow Canadian companies to global scale?
- What role should government play in supporting the digital economy?

Finding answers to these questions is complicated by the fact that emerging digital technologies do not fit comfortably within the framework of traditional development strategies. The contribution of digital technology cannot easily be measured by conventional yardsticks, such as the scale of bricks-and-mortar investment, the number of jobs created, or the value of merchandise exports. A key challenge for governments is how to measure the value of investments in digital technologies and their impact on jobs, incomes, social inclusion, and productivity.

For many years, federal government policy focused on the hardware side of the telecoms and mobile devices sector. Government support played a crucial role in Canadian success stories like Northern Telecom (later Nortel Networks) and Research in Motion (now BlackBerry). But as the subsequent travails of these two companies show, the hardware sector has been hard hit by the rapid pace of innovation, including the emergence of lower-cost hardware producers, located mostly in Asia, and platform-based companies. Official policy needs to take account of the shift in innovation from devices and products to systems, networks, applications and services based on software code.

Research conducted under the Creating Digital Opportunities project confirms that software and data hold the key to Canada's success in the digital economy.^[1] The first step is to identify niches where we can be global leaders. Our strategy should have two main goals:

- Encourage the creation of promising new ventures.
- Help companies that have demonstrated their commercial potential to grow to a scale that enables them to succeed in the global marketplace.

While this report focuses on the opportunities of the digital economy, we cannot ignore the threats. As the repeated examples of the new platform companies has made evident, virtually no sector of the economy is immune to disruption by the rapid spread of digital technologies. The continuing diffusion of cloud computing, social media, data-based technologies, the Internet of Things, and the immanent introduction of 5G mobile technology will only accelerate the trend. The challenge for Canada going forward is to ensure that we turn these potential threats into new opportunities.

1 The material in this report draws upon the extensive body of research conducted by members and partners of the Creating Digital Opportunity Research Partnership. The results of this research can be found in papers and presentations on the web site at: <https://munkschool.utoronto.ca/ip/cdo-papers-and-presentations/>.

GREEN PASTURES APLENTY

THE HORIZONS OPENED BY DIGITAL TECHNOLOGY are virtually endless. As several observers have noted, not only are the tools for writing software advancing at an exponential rate, but they are enabling more and more people to collaborate within and between companies in writing ever more complex software to perform more complex tasks.

The shift from embedding control mechanisms in hardware systems to incorporating them in software is propelling the digital revolution beyond the information and communications sector to virtually every part of the economy.

Thus, the emergence of new materials has changed manufacturing by introducing new software layers into traditional machining processes. Instead of old-fashioned “metal bashing”, metal manufacturing now centres on manipulating the microstructures of materials. Consumers now benefit from, among others, the rapid growth of online shopping, and services such as Uber and Airbnb. Financial technology start-ups, known as fintechs, are making deep inroads into banking, investment management and insurance, transforming decades-old processes and posing a serious threat to established players.

The efficiencies of computer power are eroding long-standing barriers to market entry. These days, an entrepreneur with a modern laptop and a few hundred dollars of software can run a global business — and, indeed, many do so. This shift dramatically reduces the cost of starting a new business, but also heightens uncertainty on where the next disruption will come from.

The current phase of the digital revolution is marked by the adoption of enabling technologies that perform tasks never before thought of as pre-programmed or routine. In the Canadian context, sectors especially well-positioned to take advantage of these technologies include:

- Artificial intelligence
- Medical advances in smart technology, stem cells, genetics and plasma.
- New encryption standards that support quantum computing.
- Blockchain intellectual property, including smart contracts.
- Breakthroughs in quality of life, including the internet of things, transport and communications

Our long-established primary and secondary industries also offer rich pickings. For them, the digital economy holds the promise of rising productivity, expanded product choice, lower risk, and super-efficient global production networks. But the pace at which various players are adapting is uneven. For example, our research has highlighted a marked contrast between and within the agri-food and mining sectors.

In the case of agriculture, digital technologies are becoming embedded at almost every level, from remote farms to the global distribution network. Providers of digital services and venture capital funds see farming and food processing as tempting targets for investment. But progress in our mining industry has been more uneven. One reason may be the long investment cycles for the development of new mining projects and the greater capital intensity of mining projects. Regardless of the reason, our research has indicated that there is a much greater variation in the deployment of digital technology in different subsectors of the mining industry and across different regions of the country.

A note of caution is in order. We dare not lose sight of the profound economic and social issues raised by the accelerating digital revolution. Even as policymakers, businesses and others seek to promote disruption, they also need to contain the turbulence that it causes. That applies especially to labour obsolescence. The Brookfield Institute estimated in its 2016 report *The Talented Robot* that about 42% of work activities in Canada can be automated using current technologies. In the process, almost one in five workers stand to have 70% or more of their activities turned over to machines, networks and platforms.

Even those numbers may not capture the full scale of the coming upheaval. Our research indicates that the focus on labour substitution (the replacement of workers by technology) vastly underestimates the breadth and numbers of jobs at risk. Technology, combined with business model innovations, can also make many tasks superfluous. They won't necessarily be automated – they will simply disappear. This is not new. The rise of digital media over the past two decades resulted in the decline of newspapers – and the loss of over 40 per cent of jobs in Canada's pulp and paper sector. Similarly, the move to on-demand automated and electric services threatens to disrupt the jobs not only of transport truck and taxi drivers, delivery, courier and mail workers; It may also reduce or eliminate the work of many car dealers, insurers and financiers, auto service and repair technicians, and many others.

While it is important to bear in mind that many jobs will be automated or disappear, new kinds of jobs and careers will arise, and many more will be transformed, and indeed enhanced, by digital technologies. Recent research by the Brookings Institution and the Information Technology and Innovation Foundation in the US has documented that employment expanded overall through the period of rapid technological change over the past 40 years. The challenge will be to ensure that Canada's labour force has the skills needed to work with emerging digital technologies, from artificial intelligence and blockchain to social media platforms.

CANADA'S MIXED RECORD

CANADA HAS NOTCHED SOME NOTABLE ACHIEVEMENTS in the transition to digital technologies, in both the global and local contexts. To cite a few examples:

- A growing number of domestic companies, such as Shopify, Wattpad, Kik, Slack and Hootsuite, are making their mark far beyond our borders.
- Some well-established companies, such as OpenText, the major telecom providers and CAE, are successfully adapting to changes digital technologies and markets.
- Local clusters across the country have attracted investment from digital giants such as Microsoft, Google, IBM, and Ubisoft.

Beyond the business world, universities and colleges across Canada are turning out graduates with the skills needed to expand local resources in networking, cloud computing, artificial intelligence and other relevant technologies. And governments at all levels increasingly recognize the importance of promoting domestic expertise in such digital applications as artificial intelligence, automated vehicles, additive manufacturing and blockchain, among others. An August 2017 article in *Fortune* magazine on the emerging tech hub in British Columbia noted that:

“With its proximity to technology hubs like San Francisco and Seattle, Canada’s western province—and in particular Vancouver, its picturesque urban centre—could have the most to gain from its national neighbour’s newfound isolationism. Both government and industry are moving to seize the moment.”

But Canadian firms hoping to catch the wave of digital technology must adapt to challenges from global players, and respond to market opportunities in a timely fashion. Witness the travails of former technology giants Nortel Networks, JDS Uniphase and BlackBerry. These companies, and others, learned to their cost that digital technology is a fast-moving target that requires co-ordinated and nimble strategies.

The good news is that, despite the dislocations caused by these companies' troubles, our research shows that new digital firms are emerging and growing to global scale in some of our leading innovation hubs. New entrants are building on the entrepreneurial skills, deep talent base, strong research infrastructure and increasing sources of finance to develop cutting-edge products for global markets. Ottawa, discussed in more detail in the next section, is becoming a major centre for 5G wireless technology.

Canada's over-arching challenge is to recognize that a small, open trading economy must focus on specific niches. Competitive Canadian products are best suited to complement those of larger global firms, or to fill niches (sometimes referred to as “white space”) at the interstices of existing product markets.

The task facing the public and private sectors is to work collaboratively to develop a strategy that recognizes these realities. The plan must focus on customer needs and on attracting and retaining executive talent that knows how to grow and sustain large, successful enterprises. It must be updated regularly to keep pace with fast-moving changes in the marketplace.

At the same time, policymakers must continue to focus on specific handicaps that limit Canada's ability to take full advantage of the digital technologies:

- One of the biggest obstacles to the future growth of the digital economy is the **shortage of Canadian-based patient capital for high-growth companies**. Promoters of digital technologies emphasize their ventures' strong growth prospects, but the reality is that high growth usually implies greater risk, which is a deterrent to traditional sources of investment in Canadian capital markets.
- **The relative size of Canada's domestic market** means that companies must export at an early stage as a base for global success. The shortage of patient capital and the lack of key management skills makes it difficult to grow small startups into successful high growth ones.
- **Canada's record in building local successes into global powerhouses is decidedly mixed**. Promising start-ups all too often end up either moving to the US or being sold to foreign (usually US) investors. Without high-growth companies of global scale, we will lack the training ground for managers with the skills needed to shepherd start-ups into successful scale-ups.
- The federal government and several provinces have introduced valuable initiatives in recent years to support startups, and to increase funding for the venture capital market. But a steady flow of start-ups will not sustain momentum if we cannot transform these ventures into successful global businesses.
- Competing successfully in the global economy increasingly depends on the ability to use **intellectual property and propriety standards as part of a competitive strategy to create what is called "room to operate"**. Canadian innovation strategies need to pay greater attention to these critical elements of success in the digital economy.
- **Canada has a loose innovation system that links initiatives in advanced technologies and software, but lacks a coherent focus**. All too often, the various players—colleges, universities, small and mid-sized businesses, large companies, public laboratories, innovation intermediaries and governments—are not working towards a common goal or, even worse, are working at cross-purposes.

Canada's success will be determined by our firms' ability to seize the global opportunities in new digital technologies. The best way to do that is to tap into global markets and production networks while gaining maximum traction from supportive innovation ecosystems close to home. The next part of this report examines in more detail the need to strengthen these linkages between the global and local dimensions of the digital economy.

PART TWO

FROM GLOBAL **TO LOCAL**

INTRODUCTION

THE DIGITAL ECONOMY IS DRIVING A PROFOUND SHIFT in the way businesses organize themselves. Industries that were once self-contained and unchallenged on their home territory are being drawn ever more tightly into new technology platforms and global production networks, which draw their dynamism from collaboration with a variety of players across borders and across sectors.

The Canadian enterprises best placed to thrive in the digital economy will be those able to connect to these platforms and networks, or identify niche positions that they can fill in global markets. Thanks to the power of digital networks, cloud computing and mobile software, they can sustain these cross-border links in ways that were never possible in the past.

The primary input for this software-driven breakthrough is talented, skilled labour. It is increasingly being applied to the analysis of large data sets and its primary output is intellectual property. Both sides of the software equation are intangible, and can thus easily be harnessed across national borders, and across traditional industries.

But another critical dimension is also at play. Whatever the importance of global networks and markets, businesses fare best when they are supported by deep roots in their local and regional innovation ecosystems. These roots are nurtured by strong connections among related firms and both locally and nationally-based industry associations, by innovation intermediaries such as incubators and accelerators that have robust mentor and investor networks, by local research and educational institutions, and by governments, all focused on improved competitiveness in the global marketplace. In other words, economic development in the digital age depends in large measure on building linkages between globally oriented firms, whether homegrown or multinational, and regions with unique local advantages. The over-riding goal is to propel local firms to the scale needed to thrive in today's global markets and networks.

This combination of global and local, formal and informal, generates fresh ideas, attracts talent, and creates value through new business models. In doing so, these linkages encourage the risk-taking that is an essential part of entrepreneurship and innovation.

“The growing emphasis on software-based products and digital channels means that we are shifting from a world shaped by economies of scale, which are quite sticky and capital-intensive, to a more flexible environment where economies of scope based on platforms and networks dominate. The success of Canadian firms in the digital age will depend on their ability to develop and scale up products that can sell into these global markets. Those firms that do so effectively will be ones that are supported by deep roots in their local and regional innovation ecosystems.”

THE LOCAL CONTEXT

FEW REGIONS CAN TAKE THEIR COMPETITIVE POSITION in the digital economy for granted. The players within a given region must work to establish their niche in the global economy, and work to sustain it against competitors from around the world. Our research leaves little doubt that the businesses best equipped to succeed are those anchored to strong local and regional support systems that sharpen their competitive edge.

One of the most effective ways of harnessing these support mechanisms is through collaborative relationships that underlie local innovation ecosystems or clusters. Local industry clusters form organically, but they benefit from the presence of underlying research and training institutions that are supported by the public sector. This part of the report focuses on the key element of successful innovation ecosystems, namely linkages between established and start-up businesses, investors, innovation intermediaries, universities and research institutes within a specific city or region.

The presence of local innovation ecosystems or industry clusters offers manifold benefits for the firms:

- They facilitate labour mobility, by helping an ever-evolving — and expanding — network of skilled workers move from firm to firm and allowing those workers to move to growing firms when more established ones begin to decline;
- They provide physical facilities for entrepreneurs and researchers to share experiences, validate each other's work, socialize... and learn from each other. Such a rich texture of collaboration cannot be achieved only through virtual connections or platforms;
- In this way, they help broaden the horizons of small and mid-sized firms, enabling them to connect with larger partners and global firms, as well as expand their reach into global markets;
- Local innovation ecosystems or clusters can be remarkably resilient. As the recent history of some of Canada's digital clusters shows, the decline of individual firms need not be the end of the road. Deep and flexible labour markets provide an efficient way to redeploy talent from declining firms into new, growing ones. The very process of combining talent from the enterprises of the past often stimulates new ideas, and generates pioneering products.

Dynamic innovation ecosystems can benefit from the support of all levels of government, but don't necessarily require the allocation of significant new funding. They can be an effective mechanism for governments to focus and target existing programs to leverage their impact on a broader range of firms. The task of governments is to help create the supportive context for related firms to participate, and to communicate their needs to local universities, colleges and research centres. They can encourage experienced actors in the private sector to offer advice and guidance to start-ups, and most importantly, assist them with the challenge of growing to global scale.

WHAT MAKES FOR LOCAL SUCCESS?

A REGION'S ECONOMIC SUCCESS IN THE DIGITAL AGE depends heavily on the flexibility of individual businesses, industries and academic institutions to adapt existing knowledge and resources to new, commercially viable technologies.

The local milieu plays a critical role in this process. The success of a local innovation context depends on its collective ability to absorb, process and integrate new ideas circulating in global networks. In particular, our research has highlighted the importance of informal linkages among firms, research institutions and government that encourage an open exchange of knowledge and a dynamic culture of problem-solving. The Montreal video games cluster (discussed below) is an excellent example of such fruitful interaction.

Our research has identified a number of conditions that contribute to the success of a cluster.

These conditions include: the presence of a deep **talent base** from which experienced entrepreneurs and startup firms can recruit; one or more **anchor firms** that have successfully grown from a startup to global scale to feed the growth of smaller firms and startups; the involvement of **serial entrepreneurs** who can translate their prior experience into funding, mentoring or launching new start-up firms; **savvy investors** with entrepreneurial experience who can add non-financial value to investee firms in addition to financing; a dense **research infrastructure**, including universities and corporate research laboratories, which provide the intellectual heft for growth; **incubators, accelerators** and other innovation intermediaries, which play a vital role in supporting the early development of new firms; key civic actors and organizations who bring together the economic, social, and civic interests in the community — known as **civic capital** — to promote effective collaboration.

The human element is crucial in these contexts. There is a symbiotic relationship between dynamic innovation ecosystems and their constituent actors, including startup entrepreneurs and more established growing firms, venture capitalists, researchers, innovation intermediaries and policymakers, among others.

The actors have ample space for individual action to support cluster-building, but they are also constrained by their institutional environment. Both the Ottawa and Waterloo case studies (discussed below) provide evidence of how ambitious entrepreneurs supported by a strong research base, collaborative local organizations and carefully targeted government funding can propel local innovation to new heights.

CANADA'S DYNAMIC INNOVATION ECOSYSTEMS

INTEREST IN INNOVATION ECOSYSTEMS and industrial clusters is growing across Canada as businesses, governments and educational institutions realize their value in the digital economy. We summarize the critical insights gained from several cases we have studied below.

Montreal

Montreal's video game industry, which has been the beneficiary of sustained policy support from the provincial government, provides a good illustration of a creative cluster. Together with Los Angeles, San Francisco, London and Tokyo, it has emerged over the past two decades as one of five global hubs for video game production.

Ubisoft, the French video game developer, has played a crucial role in building the linkages with the broader ecosystem of local talent that make for a successful cluster. For example, the company encourages employees to sign up for local events and cultural activities organized by various community groups. These activities have helped workers explore new creative avenues, find inspiration and develop their critical faculties. As Ubisoft's president puts it: "Montreal is our research lab".

This creative milieu has been a vital element in attracting fresh talent to the city which, in turn, has created even more opportunities. Thus, Ubisoft's partnership with actors at the National Theatre School has helped advance techniques for motion capture and 3D animation. Among other initiatives, Ubisoft has contributed to a training program to improve actors' visual performance skills.

Montreal's video-game cluster has successfully bridged formal and informal connections, and local and global resources. The outcome is a virtuous cycle fueled by a self-sustaining generation of fresh ideas and breakthroughs, an environment that keeps attracting talent, and a continuous stream of fresh trends, fresh genres and fresh business models.

Toronto-Waterloo innovation corridor

The innovation corridor between Toronto and Waterloo, which includes cities like Mississauga, Guelph, Kitchener, Cambridge, and extends south to Oakville, Burlington and Hamilton, is shaping up as a powerful digital economy cluster. The region has transformed over the past two decades from an outpost for the sales offices of multinational firms to a dynamic hotbed for home-grown start-ups and scale-up firms. It has built strong connections to global production networks, but also has strong local support systems. Two industry segments in particular—fintech and machine learning—have garnered international attention.

Our research confirms that Toronto's strongest local asset is access to globally competitive talent and the research institutions that feed the talent stream. One interviewee noted that "all the types of talent you would want when building a technology company is available here. There are lots of software developers, although they're quite expensive here". Numerous reports have also noted that Toronto is benefiting from the less hospitable climate for immigrants in the US.

According to data from LinkedIn, about 11% of workers in the Toronto region now have technology skills, the fifth highest in the world (after the San Francisco / Bay area, Seattle, Sydney and Stockholm). What's more, technology skills and services have spread into many non-technology sectors. A recent report on Toronto documented that the number of technology jobs in non-tech industries outnumbered tech industry employment by 36% in 2015.

The region's transformation over the past 5-10 years owes much of its dynamism to the presence of a group of serial entrepreneurs and investors. As one interviewee told us: "By virtue of having this growing start-up ecosystem, it creates a support ecosystem. Because doing start-ups is very hard. You need references out there of success and failure, how has it been done? This is the ecosystem advantage that (Silicon Valley) has. But that's a growing thing in Toronto."

Even so, our research has identified a number of concerns about the region's competitiveness. Among them:

- A shortage of experienced management talent compared to some other clusters, like Silicon Valley. This scarcity helps explain the difficulty of turning small, entrepreneurial Canadian businesses, even very successful ones, into global powerhouses.
- A pervasive aversion to risk in adopting new technology, especially software, on the part of more established firms in traditional sectors, such as financial services. "I would argue we're probably 36 months behind the top trends that you would see in either Europe or the US", one interviewee said.

Two Drivers of Local Context

Two non-profit groups have played key roles in contributing to the “civic capital” that has helped put the Toronto-Waterloo innovation corridor on the map.

TechToronto, founded by two entrepreneurs in 2014, has grown to over 8,500 members, 100 alumni speakers and upwards of 500 attendees at its monthly networking meetings. The organization has won support from some of the region’s largest businesses, such as Royal Bank of Canada and PricewaterhouseCoopers, as well as from the City of Toronto.

The Globe and Mail described TechToronto as a “non-partisan advocate on behalf of the tech community, a tireless champion of local entrepreneurs and their companies, and a recruiter of senior technologists from abroad”.

Alex Norman, one of TechToronto’s founders, told the Globe: “I’m seeing a lot more collaboration — at the organization level, at the government level and between companies. Four or five years ago, it was almost competitive. Now, there’s a realization that if we work together, we can build a bigger pie for the whole community.”

Similarly, Communitech, a public-private partnership, has been a driving force in Kitchener-Waterloo. Started in 1997, Communitech occupies an 80,000 sq ft “clubhouse” where it brings together start-ups, global brands, government agencies, academic institutions, and technology incubators and accelerators. “We work together every day to help our tech companies overcome barriers to success”, the agency’s website says.

The number of start-ups in the Kitchener-Waterloo area jumped from 155 in 2010 to over 500 in 2014. Besides Communitech, the University of Waterloo has encouraged faculty and students to launch new enterprises. Its Velocity accelerator, started in 2008, has worked with over 100 start-ups.

Ottawa shows how to bounce back

Canada's aspiring digital technology hubs can learn some valuable lessons from Ottawa.

The nation's capital was hit hard in the early 2000s by the collapse of Nortel Networks, one of the region's biggest private-sector employers. Some 16% of information and communications technology workers in the region were laid off in the aftermath of the 2001 crash.

But Ottawa has bounced back, re-emerging as one of Canada's most important digital economy clusters. Instead of relying on equipment manufacturing, as Nortel did, Ottawa's technology sector now focuses on networking and other software technologies. A prime example is Mitel Networks which, after a stormy history, has made the transition from a supplier of office switching equipment and semi-conductors to a provider of cloud communications software.

Shopify, one of Canada's most successful digital economy companies, is based in Ottawa. Among multinationals, Cisco Systems, Huawei, Ericsson and Siemens have either set up or expanded research and development operations in the region, in some cases adapting technology pioneered by Nortel.

Two players, in particular, have expanded Ottawa's links to global production networks:

- The Centre of Excellence in Next Generation Networking, a non-profit sponsored by the federal government, has set up a network laboratory that tests, certifies and validates new products and services for a number of different companies. It has its origins in a meeting convened by Invest Ottawa to discuss the needs of large multinationals. As one participant put it: "Even though a number of us were competitors in the room - we put that hat sideways to the Ottawa hat and Canada hat."
- Wesley Clover, an investment management firm, acts as an incubator and angel investor. It provides office space, administrative support and mentorship to new companies based on market needs identified by its partners, which include Mitel, Fujitsu, and British Telecom. The Alacrity Foundation, based in Victoria, BC, exports the Wesley Clover model to other parts of the world, including the UK, Turkey, France, Mexico and Indonesia. It aims to encourage angel investors and leading firms in these countries to set up new companies.

These ventures, and others like them, have made a point of playing to Ottawa's strengths. Top of the list is a pool of talented labour. Other advantages include informal social networks among company leaders and employees; a pool of mentors and angel investors to help new entrepreneurs; government incentives; and lower costs due to reasonable real estate prices and the weak Canadian dollar.

As an executive at one mid-sized company puts it: "In Silicon Valley, every year people change jobs. They only want to work for a company that has the highest valuation and shares. In Ottawa, people are passionate about what they do. They will take a company and stay there for years. They will help deliver. You can't build a great company in less than five or ten years."

Vancouver

On the surface, Vancouver is less obvious as a candidate for a successful innovation ecosystem. It has fewer anchor firms, and there have been no triggering events to unleash a surge of entrepreneurial activity. Nonetheless, the lower mainland in BC is emerging as a dynamic region with a number of enviable assets to both attract globally competitive firms and support the emergence of homegrown ones:

- On a smaller scale than some of the other examples in this section, Vancouver is home to a growing number of hardware and software companies, including Sierra Wireless, D-Wave, Hootsuite, Electronic Arts, and Slack.
- Excellent universities and schools have helped give BC the fastest-growing technology workforce in Canada. The number of spaces for engineering and computer science students shot up by close to 60% in the decade to 2015.
- A sizeable stable of companies offer ground-breaking digital products and services. These range from specialized logistical software firms (such as hotel reservation software), to start-ups working on quantum computing. A quarter of all US patents originating from Canadian academic research can be traced to post-secondary work at universities in British Columbia, according to a recent study by Deloitte to support the Vancouver region's bid for the federal super-cluster competition.
- A window on fast-growing Asia-Pacific markets and proximity to Hollywood, the major consumer of games, animation and visual effects software.
- Strong technology-based commercial links across the Pacific, especially with China. Many small Vancouver-based firms provide software and software services in Chinese for clients in China.

These advantages form the base for a strong emerging cluster in the region, as was recognized in the recent success of the digital cluster proposal in the federal super clusters program. However, the unaffordable housing prices in the lower mainland constitutes a serious obstacle to overcome if it hopes to attract the highly skilled knowledge workers essential to the digital economy. It must address this issue or it jeopardize its ability to maintain one of the critical ingredients that are necessary to support the growth of its knowledge-based cluster.

What about the rest of the country?

The digital revolution impacts every individual and every business in Canada, no matter where they are located.

The transformation holds huge promise for heavily-populated cities and regions that can stitch together the advanced clusters discussed above. But it creates much uncertainty for communities endowed with fewer local resources. Not every city and region of the country is endowed with the configuration of assets required for a strong digital cluster and many communities face the risk of marginalization.

For example, changes in consumer behavior enabled by platform technologies continue to reshape retail environments. Residents of even the smallest towns are already able to order their clothes, their books and probably soon their food and medications online. They no longer need to watch movies at their local cinema, nor even visit the local doctor's office for basic medical advice.

At the same time, smaller and mid-sized cities with industrial specializations of an earlier era face the challenge of restructuring their local economies to keep pace with these profound digital transformations while maintaining the quality of life that residents enjoy. Located too far outside existing 'digital corridors' such as the one between Toronto and Waterloo described above, these places often struggle with a smaller firm base, a smaller pool of suitably skilled labour, and uncertainty about how to proceed strategically in such a turbulent and rapidly changing environment.

London, Ontario, is one example. This mid-sized city has more than 300 indigenous 'creative' digital firms, and is home to a dynamic insurance industry, a highly regarded university, plus a college with a faculty of technology. Several innovative local government and grassroots initiatives have emerged to support revitalization and restructuring of the local economy and especially the workforce.

However, local tech firms do little research and development, have weak networks with both the university and with traditional industries, and tend to recruit talent from outside the city. Students have uneven access to digital technologies in the classroom, residents to advanced education in technology sectors, and immigrant groups and women are under-connected to vehicles for digital innovation and entrepreneurship. So, while innovation may be a big part of local firms' business model, more intentional work is needed to build the collaborative structures so vital to a successful innovation ecosystem.

Yet like many other mid-sized manufacturing and rural and resource-based communities across the country caught in the crosshairs of digital transformation, these strategies remain a work in progress. The learning curve is steep and – given the momentous forces they face – unrealistic to be expected to navigate on their own. Place-based public policies to support locally-driven digital transformation will be an essential element of creating digital opportunity for *all* people and places in Canada.

NEW STRUCTURES

INNOVATION ECOSYSTEMS AND INDUSTRY CLUSTERS are one way in which the digital economy is driving a fundamental shift in business structures. At the same time, intensifying international competition, cost pressures and tighter regulation – notably environmental and consumer safety standards – are propelling innovation further down the supply chain. This means that research and development is rapidly moving from the firm that produces the end-product to a wider range of businesses along the supply chain, as well as to research institutes and end-users.

The next section of this report examines in more detail how digital technology is transforming the process of value creation across a wide range of sectors in the Canadian economy.

PART THREE

THE REVOLUTION TAKES HOLD

INTRODUCTION

DIGITAL TECHNOLOGY IS DISRUPTING almost every sector of Canada's economy. This section of the paper explores the way in which digital technologies are being applied across virtually every sector of the economy and the new opportunities and disruption that are emerging. The impact of digital technology is being felt in three important ways:

- The entry of **new technology platforms**, such as Facebook, Google, Apple, and Amazon that are creating enormous value and challenging dominant firms.
- **Reshaping existing industries**, including some traditional pillars of the economy, like transportation, financial services, retail, mining, agriculture and steelmaking.
- The creation of **entirely new businesses**, such as Uber, Netflix and Airbnb, who are disrupting the business models of long-established rivals. At the same time, the application of AI, automation and blockchain technology are creating opportunities for Canadian firms to grow and scale globally in new sectors like financial technology (fintech).

We examine each of these developments below.

“The pace of technological innovation is quickening at an exponential rate while governments' capacity to respond to the ensuing disruption remains stuck in a bygone era. This discrepancy poses a significant challenge across the digital landscape. The most effective way to respond is to adopt the same approach as our most innovative firms and industries – continuous innovation in policy and regulation to allow Canadian firms to capitalize on the digital opportunities that are open.”

IMPLICATIONS OF THE PLATFORM ECONOMY

COMPANIES LIKE GOOGLE, AMAZON, APPLE, FACEBOOK, MICROSOFT AND NETFLIX are transforming the way consumers buy and use familiar services. Their impact in the marketplace is comparable to the way the introduction of the Model-T revolutionized mass transportation in the early 20th century, and how Walmart up-ended retailing in the latter half of the century.

A common thread among these platforms is that they use digital and — increasingly — mobile technologies, such as smartphones, GPS and new payment platforms. Technological innovation has made their services more accessible and convenient to consumers. While we often think of technological pioneers as small start-ups, many of the digital disruptors are highly capitalized multinational firms that have quickly developed a huge following among consumers, making incumbent firms appear slow-moving in response.

The newcomers are blurring the lines between once-distinct businesses. Media, entertainment, information technology and telecoms are becoming intermingled. Amazon's recent takeover of Whole Foods, General Motors' and Ford Motor's drive into car-sharing, and CVS Health's bid for Aetna Insurance, among others, are redrawing the boundaries between traditional sectors. The upshot is the creation of new business models in which all segments compete with all other segments for access to end-users and consumers.

The new platforms vividly illustrate the reach of global production networks, and the importance of being part of them. Thus, the key architects of the emerging media ecosystem are not niche video distributors, nor domestic providers of fixed-line or wireless pathways to consumers, but instead providers of cloud-based services, which can deliver global processing, databases, software, networks and platforms anywhere in the world. Tech companies that have morphed into the media sector, such as Google, Apple, Netflix and Amazon, are in a powerful position to dominate these cloud-based services. The advantages of scale, and the ability to customize products and services, tilt the competitive advantage in favour of companies that can wield market power through their control of platforms.

The highly capitalized multinational platforms have a big advantage over their domestic rivals. In the case of video-streaming, so-called "over-the-top" (OTT) content providers, such as Netflix, are able to draw customers away from domestic cable, broadcasting and satellite services by offering lower prices, wider choice, greater convenience, and — thanks to their huge banks of data on viewing preferences — personalized playlists. Deep pockets, brand recognition, and a favourable regulatory environment will further reinforce their dominance.

The regulatory issue is especially contentious. Many of the new platforms have been able to circumvent existing regulations to the point where they operate largely beyond existing national frameworks. Having consumers on their side provides a distinct advantage. For example, Netflix conspicuously presents itself as a champion of net neutrality, creating a positive aura from the perspective of advocates and consumers, and defending its position as responding to consumer preference.

The result is that some of the bulwarks of Canadian broadcasting policy are now being undermined by a consumer-oriented approach that gives freer rein to streamed services than to traditional forms of content distribution.

Whatever their benefits, the new digital platforms raise a number of serious concerns:

- Governments have struggled to respond to them because they conduct their business primarily over the internet. Their ability to circumvent domestic employment law, consumer protection, unfair commercial practices, tax law and insurance protection pose major challenges to policy at all levels of government.
- These services thrive in an unequal and precarious labour market. In particular, they may compound the vulnerability of the burgeoning group of workers in the so-called “gig” economy.
- They siphon money out of local economies.
- They lobby vigorously to rewrite regulations to their own advantage, potentially undermining more fragile domestic businesses.

These concerns create a dilemma for policymakers. Are jurisdictions that accept these platforms showing openness to innovation? Or, by solving one problem, are they exposing themselves to other equally (and perhaps more) serious ones? Similarly, are services such as Uber and Airbnb contributing to local economies by offering consumers more choice and creating jobs? Or are they distorting local economic activity, creating precarious jobs and helping to widen the gap between society’s haves and have-nots thus undermining the government’s stated objective to foster most inclusive innovation?

One thing is increasingly clear: the pace of technological innovation is quickening at an exponential rate while governments’ capacity to respond to the ensuing disruption remains stuck in a bygone era. Public regulatory regimes are struggling to keep abreast of the rapid pace of innovation in the platform economy. This discrepancy poses a significant challenge across the digital landscape.

RESHAPING TRADITIONAL INDUSTRIES

THE UNCOUPLING OF VALUE CREATION FROM PRODUCTION is shaking the foundations of Canada's old industrial economy. Increasingly, fabrication and processing contribute less of the value added in traditional industries like steel, manufacturing, agri-food, forest products and metals, while more comes from design, engineering, embedded software, research and innovation.

This shift means that we can no longer rely exclusively on productivity investments in plant, machinery and business process design, as economists have long asserted. Now, improved productivity depends to an ever-greater extent on advances in software technology. Software consists of much more than algorithms and code. It embodies a vast trove of engineering and processing knowledge from an array of sources — from the company that produces the end-product, to suppliers and researchers with a vested interest in making the product as efficiently as possible to customers and users seeking convenience and functionality for lower cost.

Recent research has concluded that the next generation of productivity gains on the factory floor, estimated at 20-40%, will come from the ability to digitally model physical objects and refine the cutting speeds and loads of specific machine tools. Innovative firms, like Autodesk with a substantial research team located in the MaRS Discovery District in Toronto, now use “generative design” to input design criteria into sophisticated software, along with parameters such as materials, manufacturing methods and cost constraints. These can then produce computerized models to be sent to 3D printers.

At the same time, information and communication technologies are vastly improving the efficiency of global supply chains, with ever more value added at locations far away from sites of physical production. Thus, forward-thinking steelmakers like South Korea's POSCO, Voestalpine of Austria and Germany's Thyssen Krupp view their future as software engineering companies that happen to produce steel.

Digital technology is playing a huge role in shaping these new industrial structures. About 80% of manufacturing involves metals and, until recently, the stages of the metallurgy largely determined the structure of manufacturing plants. Steel mills, for example, were organized into separate departments for coke ovens, blast furnaces, oxygen furnaces, casting, rolling and finishing. Similarly, since the introduction of car assembly lines in the early 1900s, auto plants have comprised distinct sections, each devoted to a well-defined task, such as a body shop, paint shop, assembly and finishing.

But these structures are being tossed aside. Thanks to advances in software, suppliers to steelmakers, car manufacturers and many others now have far wider responsibilities than simply producing parts based on a customer's blueprint. They are involved in design, development and engineering processes at much earlier stages. Software and digital manufacturing have become a bridge between players across the supply chain.

One consequence of these trends is a shift in the relationship between multinational enterprises and their local subsidiaries. Instead of looking to head office for fresh ideas, subsidiaries build networks within their own regions designed to deepen links with innovative local businesses and post-secondary research institutions. And the impetus is coming not only from management. The latest labour contract talks between the three Detroit carmakers and Unifor, the union representing Canadian auto workers, focused not only on wages, but also on production and R&D commitments.

Yet, while the digital revolution is pervasive, the pace at which various players adapt to it is uneven. Our research has highlighted a marked contrast between two cornerstones of Canada's economy: agri-food and mining.

In the case of agriculture, as recently as 2014, the average farmer's view of large, digitally-embedded equipment was "not yet". However, attitudes have changed rapidly. Digital technologies are becoming embedded at almost every level, from remote farms to the global distribution network. Commercial farmers now typically use at least one and, in many cases, numerous digital applications, such as self-guiding tillage, seeding, spraying and harvest equipment; planning and recording of fields and animals; and analysis of inventories and markets. One of the growing challenges for farmers is that the companies whose equipment they use are claiming ownership of the data produced by the farmers' use of the equipment. On other hand, digital technology is creating new opportunities for Canadian companies; Winnipeg-based 'Farmer's Edge' has become a major supplier of data and systems to farmers across North American and are now branching out to other parts of the world.

Not surprisingly, providers of digital services and venture capital funds now see farming and food processing as tempting targets for investment. Among the most attractive areas are the breeding industry and less specialized farm and food apps.

Agriculture is grounded in a large and highly competitive community of owner-operated farms, perpetually squeezed by falling real prices and rising input costs. Except in a few regulated areas such as rail transport, few segments or firms in the agri-food business have sustained market power. All these factors force players to adapt to disruptive technologies if they wish to remain competitive.

By contrast, our research indicates that the level of adoption of digital technology varies across segments of the mining and energy sectors. Fewer than 10% of mining companies are thought to have developed a digital strategy. Similarly, only 3% of oil and gas companies have created senior positions to reap the benefits of digital transformation, according to one recent survey.

On the other hand, digital technology could play a key role in developing deep-water oil and gas deposits, such as the Flemish Pass basin, 500km off Canada's east coast. Manual operations requiring large numbers of people on a production platform are giving way to automated systems, where a small number of highly trained generalists work on a remote platform connected to sophisticated mission support, in much the same way as astronauts work on the International Space Station.

Petroleum Research Newfoundland and Labrador, which coordinates research for the east-coast offshore industry and is a key participant in the recently funded Ocean's supercluster initiative, has identified integrated operations as a priority area for research and development. The agency sees numerous opportunities for digital expertise, such as ocean and subsea technology, remote sensing, and autonomous underwater vehicles.

More enthusiastic participation in digital initiatives could bring enormous benefits to the mining and energy industries. Digital technologies hold the promise of new revenue opportunities, lower costs and improved efficiency. They could also help companies meet social responsibility expectations by tracking the social and environmental impacts of global supply chains.

More broadly, today's technology can support radical innovation in the extractive resources sector, targeting the entire value chain and holding out the prospect of dramatic improvements in productivity. Thus, many production jobs in mining and oil and gas could in future be carried out from operation centres distant from actual production sites. Such jobs could be safer because workers would be less exposed to dangerous and inhospitable environments. They would also offer higher productivity, lower environmental impact, reduced energy needs, and reduced capital and operating costs.

Some analysts suggest that the slow pace of digital adoption in parts of the mining industry is not due to a lack of receptivity to new technology, but rather practical issues that challenge mining companies. Investment and upgrading decisions in mining occur on a much longer cycle, which leads to the perception that new technology carries an unacceptably high price tag. A more intractable issue at play may be the volatility of global commodity prices in the mining and energy sectors. On one hand, producers have little incentive to invest in digital initiatives when prices are high; on the other, they have little capacity to do so when low prices squeeze their profits and threaten their survival. Regardless of the cause, these sectors will be no more immune to the digital transformation than other sectors of the economy.

Digital opportunity in Canada's auto industry

The auto industry encapsulates how the digital revolution is driving big global companies towards local solutions. The sector is in the throes of massive structural changes:

- Its centre of gravity is shifting from vehicle assembly plants to the places where design and engineering work is done.
- Carmakers are reconfiguring their internal R&D departments to integrate digital technologies into vehicle operating systems, while forging partnerships with a widening array of local entrepreneurial start-ups, all with the aim of transforming their products into mobile digital platforms
- Parts suppliers face growing pressure from their carmaker customers to keep abreast of the latest technology, and at the same time bring down costs.
- New entrants, such as Tesla and Waymo are using pioneering technologies to reshape the industry, creating a challenge that the original equipment manufacturers must now respond to.
- The very definition of a carmaker is changing as the traditional companies broaden their horizons to include a wider range of transport options. Both General Motors and Ford have bought stakes in urban ridesharing services and increasingly refer to themselves as providers of mobility services, rather than auto manufacturers.

Until recently, the three Detroit-based carmakers plus Honda and Toyota, all of which have assembly plants in Ontario, did virtually no product R&D north of the border. However, this has begun to change in the past decade, as the carmakers scramble to respond to the digital economy and pressure to comply with tighter emission standards through lightweight materials and alternative energy sources.

In a recent submission to the federal government, the Canadian Automotive Partnership Council, which represents carmakers, noted that “innovation must become THE pathway to automotive industry growth in Canada”.

Steve Carlisle, president of General Motors Canada, told TalkAUTO Canada that the auto industry's future lies in locations with top-flight talent and support systems in lightweight materials, mobile connectivity, data analytics, advanced battery technology, cyber-security, software development, sensors and artificial intelligence.

“After visiting many of our top Canadian universities, I can tell you that we have these strengths right in our backyard”, Mr Carlisle said.

NEW BUSINESSES

IN MUCH THE SAME WAY AS THE INDUSTRIAL REVOLUTION gave rise to an entirely new economy during the 19th century, the digital revolution is now creating businesses that not long ago seemed like the stuff of science fiction. The opening thus created is now providing new opportunities for Canadian entrepreneur to create successful companies across many sectors and grow them to global scale.

Nowhere is this truer than in the financial services sector. Long dominated by risk-averse financial institutions, the sector has become a hotbed of innovation over the past decade. A new generation of agile financial technology firms, known as fintechs, are finding ways to deliver new services to consumers and circumvent long-established players.

“To its advocates, fintech will democratize financial services. Consumers will get more choice and keener pricing. Small and mid-sized enterprises will get access to new credit. Banks will become more productive, with lower transaction costs, greater capital efficiency and stronger operational resilience. Financial services will be more inclusive; with people better connected, more informed and increasingly empowered. And tantalizingly, fintech could help make the system itself more resilient with greater diversity, redundancy and depth.”

– Mark Carney, Governor of the Bank of England, April 2017.

The fintechs pose a sufficiently serious threat to the old order that many established players are acquiring them, forming partnerships with them, recruiting some of their top talent, and joining them in clusters. According to the April 2017 Global Fintech Hubs Federation Report, over US\$17.4 billion was invested in 1,436 fintech deals around the world in 2016. China and the US were the largest markets.

These new technologies have the potential to revolutionize processes far beyond financial services. Blockchain, or distributed ledger technology, can create irrefutable, tamper-proof and decentralized records for the transfer of value, transforming such mundane processes as the recording of land ownership rights; birth and death certificates; education and employment records; insurance claims; and votes, among many others.

Governments and central banks, eager not to miss out on such ground-breaking opportunities, are taking an increasingly active interest in fintech. The Bank of England, the Bank of Canada, the US Federal Reserve and the People's Bank of China are all experimenting with central bank digital currencies for public payments. The Bank of Canada recently concluded that digital currencies may empower central banks to respond more quickly to systemic shocks, better gauge the efficacy of monetary decisions, and add transparency to financial markets.

Canada has already made a mark in fintech. According to Deloitte's latest Global Fintech report, \$183 million was invested in fintech in Canada in 2016. More than 80 fintech companies across the country have attracted nearly

\$1 billion in investments since 2010, according to Payments Canada. A recent Accenture report has identified 140 fintech companies based in Canada, and a number of fintech incubators have taken root, especially in Toronto.

Canada is well-placed to be a fintech leader, thanks to:

- Our healthy, well-structured financial system.
- A relatively streamlined regulatory environment, compared to the US.
- Advanced technology ecosystems.

Even so, there is room for improvement. Most banks, insurers and other financial-service providers are still struggling to work closely and effectively with the fintechs. The regulatory landscape poses numerous challenges for innovators to navigate. Furthermore, Canada's low-cost fintech incubators are far below the scale of those in London and New York, and the more expensive ones demand rents far above what most start-ups can afford.

Our research has concluded that Canada requires more active government leadership to drive the fintech sector's growth, and could benefit from both a national fintech strategy and a fintech advisory board.

THE CHALLENGE AHEAD

THE PIONEERS OF THE DIGITAL ECONOMY have aligned themselves so successfully with consumer interests that they are now widely seen as emancipatory and innovative disruptors of an unpopular status quo. They are forcing many of the most powerful players in the "old" economy — among them, auto assemblers, steelmakers, media outlets, banks and insurers — to raise their game. As they gain traction with consumers, they are also challenging government policies and deterring new regulatory intervention.

The lower capital costs required to start and expand a disruptive platform gives digital businesses a distinct advantage and creates numerous opportunities for entrepreneurs to launch their own business and expand onto a global scale. The rapid success of recent upstarts and the challenge they pose for established firms demonstrates the enormous benefits that can flow from digital disruption.

But disruptive innovation in regulated markets is also stoking tensions. Existing players typically contend that they are at a disadvantage because they are subject to costly obligations that do not apply to the newcomers, such as being responsive to remote communities, upgrading costs, and investing in human capital and skills retraining. These arguments often carry considerable weight with politicians and regulators.

Canada's ability to position itself as a leader in the digital industrial economy will depend to a large extent on how governments and regulators navigate these fast-moving challenges. The fourth — and final — part of this report examines a variety of policy options.

PART FOUR

CHARTING THE WAY FORWARD

THE POLICY CHALLENGE

THE PREVIOUS SECTIONS OF THIS REPORT have identified some of the challenges facing Canada in its efforts to capitalize on the digital revolution, as well as the opportunities that it creates. Despite these challenges many policy supports are in place to help firms exploit these opportunities. The over-arching challenge is to recognize that a small, open trading economy such as Canada must focus on specific niches where Canadian firms and industries have the promise of competing in global markets. At the same time, we must ensure that firms across all sectors of the economy are leveraging the potential of digital technology to expand their market opportunities. Our goal must be to align our policy supports at all levels of jurisdiction to help firms and communities minimize the risks associated with the challenges while taking maximum advantage of the opportunities. Canada's ability to position itself as a leader in the ever changing and expanding digital economy will depend on how effectively governments and policy-makers navigate these fast-moving challenges

This section of the report builds on and updates the policy recommendations made in a previous report produced for this project, *A Policy Agenda for the Digital Economy*.^[1] In the period since that report was released, the government has undertaken a major expansion and streamlining of its innovation policies. While supporting these initiatives, we must ensure that the current policy mix is adequately aligned with the needs of Canadian industry, and to fill gaps that have been identified.

BUILDING ON RECENT INITIATIVES

SINCE 2016, THE FEDERAL GOVERNMENT has introduced a wide range of new innovation policy instruments.^[2] The 2018 budget alone streamlined the delivery of more than 90 federal programs that support business innovation. For the most part, these measures represent a much-needed update of Canada's innovation support policies, but most have not focused directly on the digital sector of the economy and the challenge posed by new digital technologies.

This section highlights some of the new policies, and identifies potential gaps or limitations in their support for the digital agenda. Among the most important recent initiatives are:

- The **Innovation Superclusters Initiative**, unveiled in the 2016 budget, and formally launched in February 2018. The initiative provides support for five years to five consortia across the country: Canada's Digital Technology Supercluster, Protein Innovations Canada Supercluster, Building an Advanced Manufacturing Supercluster, the AI-Powered Supply Chains Supercluster and the Ocean Supercluster. While only one is specifically focused on digital technologies, all of them involve the adoption and use of digital technologies in

1 <https://munkschool.utoronto.ca/ipf/files/2016/02/IPL-White-Paper-No-2016-2.pdf>.

2 While our focus is on the federal government, we recognize that many of the provinces have also instituted policies that complement those at the senior level of government.

their respective sectors.

- The **Strategic Innovation Fund** combines existing innovation programs for the aerospace and automotive sectors into a single fund that expands support for new and emerging technologies, including digital, life sciences and clean technologies.
- **Innovative Solutions Canada** is a Canadian version of the successful SBIR program that is designed to position the federal government as a first customer for innovative small businesses bringing their products to market. Like the SBIR program, it will potentially take the products through three successive phases leading to eventual procurement by government departments and agencies.
- **Innovation Canada** is designed to be the single point of contact for innovative companies, directing them to the most appropriate programs and departments (including provincial and territorial ones) to meet their needs.
- The **Venture Capital Catalyst Initiative**, unveiled in December 2017, allocates \$400 million through the Business Development Bank of Canada to secure more late-stage funding for high-growth businesses. The program will help established companies hire skilled employees, test-market new products, and expand into new markets at home and abroad.
- Additional funding for the pan-**Canadian Artificial Intelligence Strategy**, to be delivered through the Canadian Institute for Advanced Research and the Institute for Quantum Computing, as well as new funding for the **Smart Cities Challenge Fund** which is generating a tremendous amount of grass roots activity in cities and regions across the country.

The federal budget of 2018 added a number of important new initiatives. Among them:

- Renewed funding for the **National Research Council**, including \$30 million a year for an **Ideation Fund** to allow NRC scientists working with post-secondary institutions and businesses to target breakthrough research ideas. The budget says that this program will be modelled on **DARPA** in the US Department of Defense.
- Support for firms with high growth potential will be promoted by consolidating the **Accelerated Growth Service** and the **Concierge Service of IRAP**. The combined program will reside within Innovation Canada.
- Consolidation of federal innovation programming around four flagship platforms: the **Industrial Research Assistance Program** (which also receives additional funding), the **Strategic Innovation Fund**, the **Canadian Trade Commissioner Service** (including the amalgamation of multiple trade promotion programs) and the **Regional Development Agencies**. Innovation funding for firms up to \$10 million will be channeled through IRAP and the regional agencies. Funding above \$10 million will be the purview of the Strategic Innovation Fund. It also proposes that the regional development agencies place greater emphasis on helping firms scale up, and that they could become the main platform to support regional innovation ecosystems.
- A new **intellectual property strategy**, which includes funding to pilot a **patent collective** that will work with Canadian entrepreneurs to pool patents, thus providing small and medium-sized firms with better access to the intellectual property needed to grow their businesses. It also includes support for Canadian entrepreneurs to fashion tailored strategies for using intellectual property to expand sales and revenues into international markets. The final element is the creation of an **intellectual property marketplace**, which will be an online listing of public sector-owned IP available for licensing to improve access for Canadian entrepreneurs to publicly-owned intellectual property.

- In addition to consolidating the **Build in Canada Innovation Program** with **Innovation Solutions Canada**, the Government will also establish a new **electronic procurement platform** to help small and medium-sized businesses access sales opportunities with the federal government, with an emphasis on equal opportunities for women entrepreneurs.
- The Budget also proposed to allocate \$11.5 million over three years, starting in the current fiscal year for the Government to pursue a regulatory reform agenda focused on supporting innovation and business investment. The goal is to make the Canadian regulatory system more agile and responsive, so that businesses can explore and act on new opportunities.
- A **National Cyber-Security Strategy** with funding over five years to support the strategy, as well as funding for the Communications Security Establishment to create a new **Canadian Centre for Cyber Security**, funding for the RCMP to create a **National Cyber-crime Coordination Unit**.

The number of new programs, the increased funding, and the streamlining and rationalization of federal business innovation programs introduced in the past three budgets represent one of the most dramatic set of changes to innovation policy over the past three decades.

Many of these changes correspond to recommendations made in our White Paper, *A Policy Agenda for the Digital Economy* and will support a new trajectory for Canadian innovation. Despite this progress, there are a number of important policy areas where further work remains to be done. As previous sections of this report document, the rate of change in the digital economy is accelerating and will only continue to increase, at a pace that is difficult for our institutional, policy and regulatory frameworks to keep up with. The most effective way to respond is to adopt the same approach as our most innovative firms and industries – continuous innovation in the policy and regulatory frameworks to allow Canadian firms to capitalize on the digital opportunities that are open.

A FEDERAL INNOVATION AGENCY

A CRITICAL ELEMENT OF SUCCESSFUL DIGITAL STRATEGIES elsewhere has been the active involvement of a low-profile, peripheral, innovation agency. Notable examples include the US Department of Defense's Advanced Research Projects Agency (DARPA); Sitra in Finland; and the Office of the Chief Scientist in Israel, now the Israel Innovation Authority. Despite significant national and agency-specific differences, the common experience of these countries holds important lessons for Canada.

These agencies owe much of their success to their relative insulation from short-term political pressures. They are staffed by technology experts, often drawn from relevant industry sectors, whose highest priority is to make critical investments in firms that are developing emerging technologies, some focused on meeting the needs of specific governments departments or agencies (DARPA), but others geared towards developing innovative products to fulfill new and emerging needs on global markets.

These agencies make a modest demand on the public purse, with budgets typically in the range of \$300-400 million a year. While not every investment is a guaranteed success, the model has been effective in putting innovative firms in these countries on a path to develop emerging products for the international marketplace. The program design and peripheral location of these agencies have a number of advantages:

- They are less vulnerable to political interference or lobbying by special interest groups, precisely because they control few resources.
- The fact that they occupy a peripheral status within the public sector forces them to develop novel policies. Deprived of the resources to allocate credit or grant aid, policy makers have an incentive to develop alternative programs, often turning to private-sector partners to develop new ideas and facilitate implementation.
- Agencies with limited resources are exposed to fresh ideas about how to promote restructuring. They are more likely to cultivate alliances with non-traditional domestic or international actors, encouraging them to be imaginative and to circumvent bureaucracy.

The new Ideation Fund announced for the National Research Council is intended to create this kind of program for Canada. However, it is uncertain whether the recently renewed structure and mandate of the NRC corresponds sufficiently to the idea of a “peripheral agency”. Funding, which is limited to \$30 million a year, will be directed towards promoting collaboration between NRC scientists, post-secondary researchers and entrepreneurial firms.

This raises questions whether the new program will have a comparable effect for the digital economy that the peripheral agencies described above have performed in their national economies. We recommend that this new program be monitored closely with an eye to both spinning it out of NRC to become a true “peripheral agency”, and expanding its budget to the point where it can play a truly transformative role for the digital economy.

A SCALE-UP STRATEGY FOR GLOBAL EXPANSION

WHILE CANADA HAS MADE SIGNIFICANT STRIDES in supporting the start-up of innovative firms, we are not focused sufficiently on helping those firms grow to global scale. Without ensuring this, we will miss out on some of the most important opportunities that the digital economy affords. Despite the measures introduced in recent budgets to address this challenge, the government can go further.

We define scale ups as a particular group of companies that have achieved a minimum of \$10 million in annual revenues, a growth rate of 20 per cent a year for more than three years, and more than 10 employees at the start of the period.^[3] They have established banking relationships, demonstrated growth, are profitable and are generating over \$10M in annual revenue. Current programs focused on scale-up firms, such as the Accelerated Growth Service, provide part of the solution, but the federal and provincial governments need to undertake a coordinated review of how their talent, skills and innovation programs can be focused on helping firms of this size grow to a minimum of \$100 million in annual revenues.

³ This definition draws upon the OECD, the UK Scale-up Report and our own CDO research.

The review should examine the critical challenges facing these firms – expanding their revenue base, particularly by accessing global, not just continental markets; recruiting, retaining and developing the necessary managerial and technology talent (and ensuring that the talent we are training at post-secondary institutions stays in Canada); and ensuring adequate access to patient, long-term capital, not just start-up venture capital.

A critical requirement for scale-up firms to succeed is access to talent. The government needs to adopt strategies to deal with the emigration of qualified students trained at Canada's publicly funded post-secondary institutions. Both federal and provincial governments should work with domestic digital firms on strategies to retain highly qualified talent that is in demand around the world.

Among other recommendations advanced in *A Digital Policy Agenda for Canada* were the establishment of sales and marketing consortia to help give Canadian digital firms the breadth needed to penetrate emerging markets, especially those in East Asia, where size matters. We also suggested that the federal and provincial governments should increase direct support for scale-up firms, such as foreign exchange risk insurance, and more aggressive and targeted foreign intelligence on international sales opportunities. These tasks could be part of the expanded mandate for the expanded Trade Commissioner Service.

We feel there is an opportunity for the government to use existing programs, such as the Accelerated Growth Service, to integrate the services offered by various government agencies to support the growth of these companies, under the leadership and guidance of the Business Development Bank of Canada's advisory services groups. Companies that qualify for the Accelerated Growth Service, should have to invest in BDC's growth driver program and have the BDC lead them through the programs. Program applications at federal and provincial levels should also be harmonized so that companies only need to provide their financial data once. With the BDC's approval, they can then qualify and be fast-tracked for support through all the available programs, whether funding ones, or organizations like the Standards Council of Canada or the Canadian Intellectual Property Office.

There is also a need to create regular discussion forums for the CEOs of Canadian scale up firms to speak directly with government decision-makers about ideas that can improve the innovation support system for their companies.

A related question addressed in *A Digital Policy Agenda for Canada* is how government policies can support these businesses to remain Canadian once they reach this critical size. While venture capital may be useful to launch start-up firms, it is primarily short-term and companies are often sold off within 3-5 years. Furthermore, when firms reach their scale up phase, as defined above, they clearly require access to different forms of long-term patient capital. The critical challenge for government is how to mobilize existing pools of capital for this purpose.

AN INTELLECTUAL PROPERTY STRATEGY

THE IMPORTANCE OF PATENTS, designs and other Intellectual property has grown enormously over the past 10 to 20 years as businesses and researchers seek to protect their cutting-edge technologies. Yet Canada has been slow to appreciate the value of intellectual property, with the result that many homegrown ideas end up being owned by foreign companies, and used to their own — rather than Canada’s — advantage. This means that Canadian firms are all too often paying royalty fees to foreign companies, instead of investing those funds in their own research efforts. Innovative businesses must be able not only to protect their ideas, but also to enforce that protection through trade agreements, standards and, if necessary, litigation.

Budget 2018 broke new ground with the announcement of the national intellectual property strategy. Like many others, we believe that such a comprehensive policy framework will go a long way towards ensuring that more of the benefits of publicly-funded research and domestic talent will remain in Canada. Each of the three elements of the new strategy will need to be monitored carefully as it is implemented. Changes will need to be made in “real” time to ensure that the policy is working as intended.

Administrators of the new programs must also recognize that global supply in IP-intensive industries works differently from conventional production economies. Policies need to ensure that promising Canadian innovators are provided with the IP-related resources to compete on a level playing field with multinational firms. Canadian organizations that grant intellectual property rights also need to focus on increasing the amount of Canadian owned IP rights that are filed and registered globally. It is also imperative to recognize the growing connection between IP rights and data.

CREATE A NATIONAL DATA STRATEGY

AS CANADA ADOPTS A WIDE RANGE of environmental measures to reduce our dependence on carbon-based sources of energy, there is also growing recognition that data is becoming the new oil. This recognition must be reflected in a national data strategy to ensure that Canadians own the data they create and that the government possesses the tools that grow our economy, protect our privacy, public safety, democracy and public health.

The establishment of clear property rights in data is a central part of this strategy. With clear and full property rights given to individuals, citizens will control how their personal data is accessed and used. In addition, there is a need to ensure accurate data storage facilities to maintain the quality and accuracy of the data and verify its ownership.

The simplest solution to guaranteeing property rights to data would be to: i) grant full property rights to people in their personal data; and, ii) establish a fully transparent open-source with limited access/uses rights to data gathered as part of public or semi-public activities, such as transport services (run by either public or private companies) or smart city initiatives.

There is also an urgent need to recognize the growing role of data in international trade in services. While we currently have a sophisticated system of rules for governing trade in goods, services and capital, there is no such system for data. In anticipation of the growing value and importance of data in the digital economy, we recommend that the government develop a set of rules for governing the international transmission of data flows as an integral part of Canada's trade agreements.

ADOPT A NATIONAL STANDARDS STRATEGY

ALONG WITH THE IMPORTANCE OF intellectual property rights and data in the digital economy is a recognition of the strategic importance of international standards as a competitive tool. The definition and international enforcement of technology standards in both hardware and software play a central role, alongside intellectual property rights, in defining the "room to operate" that companies enjoy in the defence and promotion of their innovative products.

More effort is needed to educate Canada's digital companies about the options available to participate in international standard-setting bodies and how technology standards can be used as an additional tool to protect and enforce their IP. To this end, we recommend that international standards policy should be embedded within all Canadian innovation policies.

Furthermore, the government should ensure that Canadian technology firms gain prominent positions in international standard-setting bodies. The goal is to maximize the degree to which Canadian technology products are embedded in, and protected by, international standards, as well as to ensure a strong voice for Canadians in setting and enforcing international technology standards.

EMBED DIGITAL TECHNOLOGY **IN ALL SECTORS OF THE ECONOMY**

AS DOCUMENTED IN PREVIOUS SECTIONS OF THIS REPORT, no sector of the economy is immune to the digital transformation. To thrive in the digital economy Canadian firms must be in the forefront of the adoption and use of digital technologies, especially software. Yet recent studies show that we continue to lag in making these investments. Reports from the Centre for the Study of Living Standards shows that under investment in software accounts for 85 per cent of the broader Canada-U.S. gap in ICT investment, which is seen as a significant contributor to Canada's lagging productivity performance.

Canada needs a national strategy to support the adoption and use of the latest digital technologies, especially software, across all sectors across the economy. This follows from the recognition that increasing functionality in digital technologies is shifting from hardware to software and that no sector of the economy, from agriculture and mining to entertainment and transportation, is immune to this transformation. Past programs have tended to focus on hardware adoption, but current trends dictate that this must be expanded to include the greater adoption and use of software. The short-lived Digital Technology Adoption Program, administered by the National Research Council was intended to promote technology adoption, but was not in operation long enough to achieve its objective. The Business Development Bank of Canada offers support to small and medium-sized businesses looking to adopt digital technologies through the Smart Tech service. Businesses may also apply for loans for investment in hardware, software and consulting services. The federal government should build on the best elements of these programs to promote the increased application of software across all sectors of the economy and all facets of the innovation spectrum, from product and process innovation to the development of new organizational, sales and marketing innovations.

STRENGTHEN REGIONAL INNOVATION ECOSYSTEMS

BUDGET 2018 HOLDS OUT THE PROSPECT of the regional development agencies playing a central role in supporting the regional innovation ecosystems discussed in Part 2. This is welcome news, but care must be taken to ensure that the agencies are staffed with experts who understand the dynamics of regional innovation ecosystems and local clusters. In a previous policy report *Cluster Policies and Cluster Strategies*, we summarized the key findings of a national research initiative on clusters across Canada and the main policy implications.^[4]

While the role of the regional agencies should be closely coordinated with the federal supercluster strategy, care must be taken to distinguish between the contributions that each can make. Regional innovation ecosystems can facilitate coordination, dialogue and interaction among firms and supporting institutions at the local and regional level. Innovation ecosystems and clusters are most effective when they are used to focus the delivery of federal and provincial programs on a group of interrelated companies located in the same region.

The regional development agencies, in partnership with provincial and local governments, research institutions and the private sector, should support cluster organizations by identifying major sources of cluster strength across the country. The recently released Cluster Map of Canada, produced by Innovation, Science and Economic Development Canada in consultation with provincial and territorial counterparts, is an invaluable tool for identifying areas of cluster strength across the country.

Universities and other research institutes can support regional innovation ecosystems by aligning research and training efforts to meet the needs of local digital clusters. They can also align university investments in research infrastructure funded by the Canada Foundation for Innovation and in new research chairs, through their strategic plans, with local and regional areas of strength.

4 http://sites.utoronto.ca/isrn/publications/NatMeeting/NatSlides/Nat08/Wolfe_Cluster_Policies_Strategies.pdf

The regional agencies should support cluster development activities by offering advice and guidance to start-ups; by supporting the entry and growth of related firms into an area; by assisting scale-up firms to access the programs needed to expand their reach into global markets; by communicating their needs to local universities and research institutes; and by collaborating with relevant provincial and federal government agencies.

The regional agencies should bring existing cluster organizations at the local and regional level into a national Collaborative Clusters Network to share know-how and best practices on how to improve cluster competitiveness, as well as to provide advice on public policy and economic development strategies that reinforce cluster development.

A NEW URBAN POLICY AGENDA

INNOVATION IS INCREASINGLY AN URBAN PHENOMENON and urban spaces are the crucible for the adoption of many cutting edge digital technologies, from sensors to create smarter cities to connected and autonomous vehicles. The transformation of cities into smart, intelligent, and sustainable cities is estimated to be a \$1 trillion global market today, to \$3 trillion by the coming decade. It is the largest new digital technology application market opportunity in the world. Governments around the world have been actively supporting and encouraging their cities' digital transformations for a number of years.

In 2017 the federal government formally announced their Smart Cities Challenge initiative with a total budget of \$300 million to be delivered in three tranches over six years. Given the high proportion of our population that lives in cities and the percentage of our GDP generated in cities, the opportunities for stimulating Canada's global innovation and productivity standings in the world lie in the efficiencies created in our cities through ongoing Smart City transformations. The current Smart Cities Challenge should be used as an opportunity to both improve the quality of urban life across the country and support the opportunities for Canadian firms to participate in this expanding global market.

The policy issues related to the coming of connected and autonomous vehicles, and more broadly, intelligent mobility, are similar to those raised by the smart city phenomenon. Intelligent mobility and smart sensors will be the defining technologies of future cities. Smart cities and intelligent mobility thrust data governance, along with critical issues of land use, urban design and transportation planning, to the centre of the policy agenda. To prepare for this coming transition, we need new federal, provincial, territorial and municipal consultation and coordination processes to address four key issues:

- Data governance and infrastructure.
- Mobility infrastructure and urban design.
- Sector innovation and investment.
- Implications for sectors and labour markets across the economy.

Each of these areas requires complementary strategies to ensure that Canada maximizes the benefits and mitigates the downsides of the profound transformations that are right around the corner.

THE DIGITAL PROMISE

MOST COUNTRIES ARE POSITIONING THEIR DIGITAL SECTORS as critical drivers of future economic growth. We are confident that the above proposals, and the research that accompanies them, will help ensure that Canada is not left behind.

Not since the onset of the first industrial revolution have we seen such an interconnected set of technologies with the potential to disrupt established industries and economic patterns, as well as to generate new opportunities for future generations. We must bear in mind that a vibrant digital economy is not an end in itself. It also has wide implications for society as a whole. The ability of governments to seize the digital opportunity and lay the foundations for future growth will help determine their capacity to deal with the many other issues pressing in on them.

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