

Inspiring Unfettered Innovation



Introduction

The Internet of Things (sometimes called the Internet of Everything) is part of the Fourth Industrial Revolution: a technological shift that is happening faster than previous industrial revolutions and will impact how we live, work and interact. The Internet Age brought communications into our homes and our hands through mobile technology. The Internet of Things (IoT) is putting communications into everyday items through the extension of the internet to the physical world through rooted embedded technology to enable machine-to-machine communications, enabling devices to signal and elicit responses, transmit and analyze data. At the same as devices are “talking”, other technological capabilities are combining to make this shift significant: Artificial Intelligence (A.I.) is enabling machines and computers to carry out more complex tasks; robotics advancements are enabling greater automation of jobs, facilities and organizations; and Cloud Computing is increasing access to high speed, complex infrastructure with greater capabilities while reducing IT costs. The impact is expected to be significant: Cisco has estimated the global IoT market to be as large as \$19 Trillion by 2020.¹ As hyperconnected devices increase the linkages across our society and country, the globe is getting smaller and competition is increasing for share of the global market. Organizations that are ready for the IoT shift will be leveraging these technologies to reduce costs, increase productivity and use their data towards better business intelligence. Amidst all these technological shifts reminiscent of the emergence of the internet, the organizations that can capture data in near real-time and orient operations in response effectively will prosper.

Data-Driven Enterprises

IoT devices are already in our homes, cars and workplaces. In a few short years, global experts estimate that there will be between 20-25 billion connected devices, half of these devices will be IoT or Machine-to-Machine communications-enabled.² These devices will dramatically increase the amount of data available to organizations throughout the supply chains and consumer environments. Organizations with the best understanding of what is happening with their industry, their sector, the economy and (most importantly) their customers/users will have a strong competitive edge. This data will provide insights or business intelligence predicted by Bill Gates in his book “Business at the Speed of Thought”. **Data is the new modern currency that will empower better business strategies and economic growth.** With the amount of global data predicted to double every two years, and up to 44 petabytes (million gigabytes) by 2020 , organizations will need understand, organize and react it to the data insights.³ To do this significant changes to supply chains, organization structures, and organization skills will need to occur for many making leadership and talent critical to the next 10 years.

PwC has forecasted that the digital supply chains are already moving towards a fully integrated and flexible model where information and communications runs from raw materials through to end-user experience. Instead information such as client feedback from sales or marketing will be collected, reported, analyzed and then acted on, the feedback would flow immediately throughout the organization allowing all aspects of the organization to respond in real time. Real-time collaboration and integration will require advancement of technology skills like data literacy throughout the organization structure. It will also require strong soft skills in an integrated organization that operates like a living organism.

Cloud Computing

Cloud computing will likely play a significant role in 2017 as it brings significant benefits to organizations by outsourcing computational infrastructure to larger suppliers with potential to provide more advanced features in data collection and security. For small and medium businesses in Canada, IT infrastructure and software can represent 80% of their IT budget and outsourcing these activities can represent reduced business costs for higher quality products. This trend towards heightened productivity is also providing a concentration of platform providers where larger players are able to bring economies of scale as well as capture more data. As a result, Cisco has predicted up to 93% of all data by 2020 will be in the cloud.⁴ ICTC's research into cloud computing found that half of the Canadian enterprises have adopted some cloud services, resulting in lower operating costs and creating a growth area estimated to provide \$8.2 billion to the Canadian GDP by 2018. However, this is small part of the global market estimated to reach \$241 billion by 2020.⁵ Overall, this shift provides on average 4.1% reduction in costs and a 2.9% increase in revenues.⁶

With millions of new connections between cloud computing, billions of IoT devices and machine-to-machine communications, an exponential ramp up is expected for mobile network demands. Governments across the globe are moving to allocate radio frequencies towards a Fifth Generation (5G) network.⁷ Likewise, more addresses are needed for the millions of devices in Canada – an indicator if Canada's systems are ready for the conversion to IoT. International groups in preparation for the IoT demand for more addresses created the new naming convention IPv6 (Internet Protocol version 6) that would provide a near infinite number of addresses (compared to the 4.3 billion under the old protocol). Canada's adoption of this new naming convention sits at just 15.62% compared to the US's 29.45%, and slightly below the world average of 16%.⁸ If the adoption of IPv6 is an indicator, Canada's IT infrastructure is behind our main competitor and trading partners in the US, however keeping pace roughly with the global markets. CIRA's tracking of this metric will be a key indicator for Canada's readiness for IoT.

Automation and Thinking Robots

To see what is occurring in near-real-time, organizations need to gather information, analyze it and decide how to respond quickly. An automated organization with an integrated supply chain has the potential to respond quickly to input, provided it analyzes and takes the appropriate response. Artificial Intelligence (A.I.) can enable a rapid evaluation and faster response than humans can. And in an integrated supply chain, real-time decisions can adjust operations from raw resource suppliers to end users. Leaving aside the “Terminator” debates about artificial intelligence, these combined capabilities of data and business intelligence, artificial intelligence and automation through robotics, can take over routine and repetitive tasks with the ability to adapt and adjust to optimize efficiencies. When you can combine big data and processing capabilities, **A.I. possesses a potential game changer that can make IoT a revolutionary event – shifting work and advancing the capabilities of any object we use in everyday life.**

Changing Skills and Workplace

If machines are carrying out all aspects of operations, what is the human role in the future workplace? First, it is important to remember this does not likely mean the elimination of all jobs: even decades after the ATM (automated teller machine) arrived, we still have tellers to carry out higher-level activities. The work shifted, rather than leading to complete replacement and companies allocated resources to deal with things the ATM could not.

For More on the Talent Challenges, see ICTC’s Talent Imperative policy paper.

Brookfield Institute for Innovation and Entrepreneurship reported that up to 42% of all Canadian jobs could be automated in the next ten years, with a primary impact on lower-skills jobs. Companies are realizing the potential benefits as IoT-enabled robotics do not require rest, benefits, or incentives. Moreover, enabled with A.I. they can reduce costs via efficiencies and reduced errors. But, it is not just warehousing and driving jobs that will be impacted – the reduction of repetitive tasks will be across all industries. For example, the legal community has noted that legal tech start-ups are using A.I. to automate research and analysis into judicial decisions, trends, and legal precedents.⁹ A.I. can perform these searches faster and more accurately, focusing lawyers on the end analysis and serving the client. It also has the added benefit of reducing the costs of legal services and making legal advice more accessible.

LEGAL A.I.

The lack of technology adoption and the potential impacts of A.I. on Canada's legal community was noted by Ontario's Attorney General in December, 2016 at an event at Microsoft Canada. Minister Yasir Naqvi noted the legal field has been one of the slowest to take action towards the adoption of technology. University of Toronto professors founded the Blue J Legal start-up company with a "Tax Foresight tool" which helps lawyers determine how a judge is likely to rule on a tax issue. This AI machine streamlines legal research – a growing trend for lawyers. Benjamin Alarie, one of Blue J Legal's founders, explained that this type of technology is not intended to replace lawyers, but to help the legal system run more smoothly, encourage parties to settle outside of court, lower costs, and create more access to justice for people who cannot afford to hire legal representation.

As more tasks are automated, the skills in-demand for the marketplace will continue to shift work from repetitive behaviours to higher orders of work, in particular in the area of technology. ICTC's labour market forecasts outlines 182,700 job openings by 2019 due to increased demand for technology skills related to growth in A.I., data analysis, cloud computing, automation and IoT.¹⁰

Security, Privacy vs Interconnected, Interoperable Devices

It would be fair to say that security and privacy issues have been largely addressed after technological advancements have created new challenges and opportunities. Security and privacy have been playing catch-up to an ever-evolving system. These skills gaps are and will continue to be amplified by the hyperconnected IoT economy, rapid evolutions and a far more coordinated system of cyberattacks than cybersecurity.¹¹ These challenges exist with both the organizations providing goods and services as well as consumers: A global survey of the Internet of Things by the Global Privacy Enforcement Network many organizations used templates to inform users what information they collect but did not always seek to educate users.¹² With concentrated platforms in IoT emerging similar to smartphone and computer operating systems, organizations can capture vast user data from consumers who lack understanding of the potential impacts, according to concerns of privacy czars.¹³ As organizations seek to be open – such as governments seeking to provide economic opportunity through open data – limitations and prevention are needed to protect security and privacy.

IoT systems greatest attribute – bringing entire ecosystems or supply chains into a single, organized data-stream – is also its greatest security challenge. A single weakness in the interconnected system can impact the entire system, clearly demonstrated in 2016 when hackers interrupted major US websites by using the IP addresses of IoT-enabled webcams in a distributed denial of service attack (DDoS) that overwhelmed and crashed a services provider. The costs of such attacks may never be fully known but would include costs of infrastructure re-building, additional prevention measures against attacks, loss of business and down time, and costs to reputation and brand. With most Canadian SMEs lacking adequate cyber security in place for today's online economy, the risk in a hyperconnected IoT economy increases potential economic impacts to employers, employees and the national economy.¹⁴

Striking a balance between accessible information and security can be achieved: Estonia's integrated approach, for instance, allows sharing of private and public data between government institutions, while restricting access of such information to the general public. This enables Estonia's government to leverage data for better intelligence and evidence-based decisions. To ensure there is no abuse of the information, all inquiries made about personal information are recorded and every citizen has the ability to ask public institutions which information has been collected about them and who has accessed it. Appropriate penalties are applied for officials that abuse their access, such as potential loss of medical licences for inappropriate health records access.

The Value of Open

If open represents the potential security costs, why do it? Simply because collaboration and integration are the basis for where the global economy is going and required to realize the benefits of new systems like IoT. **Already the potential value and economic opportunity of data has resulted in more than 150 countries and regions in releasing their data in an open and useable format in the hopes that entrepreneurs will turn it into a value-added product generating jobs and solving social issues.** Open models are benefiting different areas of our society: Governments gain sector, regional and industrial growth, job creation and tax revenues; open models of collaboration are being leveraged in various industrial sectors such as software (open source software), through innovation clusters and shared R&D platforms, and through various online platforms for finance (Kickerstarter and other crowdsourcing funding portals), and knowledge (open, online learning and online encyclopedias like Wikipedia).

These Open Innovation models provide value to the contributors and to the end users. Such is the case for a growing use of open source software as two-thirds of the software industry today are leveraging open source products to expedite time-to-market, reduce costs, avoid vendor lock-ins and improve product quality.¹⁵ Open source software allows users to access coding (as opposed to locked products that block

accessing the coding). The most prominent open source software is Linux's Ubuntu – an operating system used in most supercomputers, across many servers like Project OpenStack, and as a key part of many cloud systems. Open source provides greater flexibility and control to the consumer and user, can allow more interoperability with other providers. The Internet of Things is dependent on the concept of devices being able to connect, communicate and interact either through compatibility. And open source software is a growing, viable alternative to closed software as the only secure option.

Use of GitHub, an online version control repository for software, allows companies across the globe share coding, edits, bug fixes and more. For the right software challenges, these collaborative platforms enable higher levels of altruistic benefits than any one company or partnership would enable. The community benefits from the individual and vice versa. Likewise, Governments are able to break down silos and collaborate across departments and with the public and private sectors, leveraging the knowledge of many.

The open collaboration trend is not new but has become a prominent part of the growing trends. Microsoft – a global software giant – has joined the Linux Foundation (an Open Source not-for-profit), signed major new partnerships with Red Hat, the largest open source for-profit company in the world, and last year was the largest contributor to GitHub for the US government. This model of leveraging external and internal ideas to enable collaboration to advance a technology was first introduced by Professor Chesbrough as “Open Innovation” in 2003. Examples in Canada abound, such as the Consortium for Aerospace Research and Innovation in Canada (CARIC) in Montreal, where government and industry players collaborate to solve technology challenges that allows all participating members to use the solutions. All CARIC members gain potential advantages over industry competitors in other countries.

Canada and the Fourth Industrial Revolution

Governments across the World are obviously eager to see their economies benefit from the enormous opportunities of the Fourth Industrial Revolution in a potential technological renaissance. The combined impacts of thinking, automated and communicating devices that can dramatically improve productivity, generate new wealth and jobs, and focus the workforce on higher-order, skilled activities provide an overall benefit that result in higher quality of life, better salaries and more opportunities related to management, creativity, and discovery. **The challenge most are facing imminently is bringing current and future workers to the skill levels needed to realize these opportunities and ensure that society does not leave behind older workers that did not grow up as digital natives.** For this, ICTC has established in partnership with Microsoft Canada, the National Digital Talent Strategy “[Road to 2020 and Beyond](#)” in 2016.

While Canadian federal leadership on open data is strong, governments would do well to internalize open innovation within its ranks. All governments can benefit from open models – with the appropriate checks and balances. The City of Toronto made its consultations on a new casino open. University of Toronto responded by mapping response to geographic areas, which allowed information to be correlated to various census information like income levels, education rates, crime, and community composition. The Public Service forward staff strategies, Blueprint 2020, noted a need to increase information sharing and collaboration, leverage the collective knowledge across departments and increase the use of technologies.¹⁶ These principles all align with open innovation and best practices of information sharing that maximizes the business intelligence and holds individuals accountable in it uses. Initiatives to develop clusters of industrial knowledge to strengthen or start-up new technology sectors can benefit from the communal support of open innovation – where the data and knowledge of the community raises the capacity of local talent, products and services.

Data will continue to be a critical part of the future of jobs and growth – companies with data and its associated intelligence will be more responsive to customers and market changes and better prepared to weather market shifts. Organizations lacking the data or the skills to harness data into improved efficiencies will see themselves outside of global supply chains demanding such capabilities.

Conclusion

The Internet of Things like the emergence of the Internet in business, shift how the economy operates and change the skills employers, governments, and employees need. For Canada to realize the potential and reap rewards for this coming change, we will need to provide added support to our teachers and students in delivering skills that graduates need in the future rather than skills to reflect jobs of today or the past.

For our business community, the focus should be on data strategies that provide a competitive advantage as well as bolstering cyber security to protect against current, future threats as well as potentially undetected intrusions in the past. Both these strategies can be expedited and bolstered by using cloud technologies: leveraging the cyber expertise, platforms and services of major providers while reducing infrastructure costs (a top technology budget item for businesses in and outside of the tech sector) and improving productivity. Effective adoption of cloud computing, data and cyber security strategies will enable industrial IoT automation and make artificial intelligence a natural progression.

For Governments, seeking to prepare workers and enable its employers in global markets, the need to leverage and build the collective growth of sectors is critical as Canada's free trade agreements makes it one of the most accessible in the World. The larger challenge will be to shift a larger group of people than ever before into new skills and opportunities effective – helping all Canadians realize better opportunities. Government can use Open Innovation to empower entrepreneurs to rethink businesses and drive new opportunities, as well as build up current organizations.

Open Innovation also provides equal opportunities for the Public Service to achieve its ideal – the effective and efficient sharing of information and insights across government.

With the Fourth Industrial Revolution, data will be the modern age commodity that will drive new business opportunities, jobs and economic growth. The cloud will enable companies to rapidly transition into a new world where A.I. has the potential to significantly heighten productivity and competitive advantage.

References

1. Cisco (2014), "[The Internet of Everything – A \\$19 Trillion Opportunity](#)"
2. Cisco (2016), "[2016 Cisco VNI Complete Forecast](#)"
3. IDC (2014), "[EMC Digital Universe of Opportunities](#)"
4. Cisco (2017), "[Growth in the Cloud](#)"
5. ICTC (2015), "[Canada's Cloud Imperative](#)"
6. PwC (2016), "[Industry 4.0: How digitalization makes the supply chain more efficient, agile, and customers focused](#)".
7. Innovation, Science and Economic Development Canada (2016), "[An Inclusive Innovation Agenda: The State of Play](#)"
8. [Google IPv6 Statistics](#)
9. Sorensen, Chris. Maclean's (2017), "[Big law is having its Uber moment](#)"
10. ICTC (2016), "[Road to 2020 and Beyond: National Digital Talent Strategy](#)"
11. ICTC (2016), "[Critical Infrastructure in a Hyperconnected Economy](#)"
12. Office of the Privacy Commissioner of Canada (2016), "[Global Internet of Things Sweep finds connected devices fall short on privacy](#)"
13. Office of the Privacy Commissioner of Canada (2016), "[Internet of Things: An Introduction to privacy issues with a focus on the retail and home environments](#)"
14. ICTC (2016) "[Critical Infrastructure in a Hyperconnected Economy](#)"
15. Black Duck Software / North Ridge Research (2016), "[Tenth Annual Future of Open Source Survey](#)"
16. Wouters, Wayne (2016), Privy Council Office, "[Destination 2020: Building Tomorrow's Public Service Together](#)"