

1. Challenge – The Aim and Importance of the Endeavour:

Evolving digital technologies are critical to the global economy and to Canada's future economic growth and prosperity. The rapid pace of innovation, along with shifting global leadership in digital technology, are creating major challenges for Canada's digital industries, but also new opportunities. This dynamism creates new opportunities for entry into the field, but also new threats to Canada's existing strengths. For Canada to benefit from this shift, we must take appropriate action. Canada's future competitiveness and our prospects for economic growth are inextricably linked to our ability to seize the 'digital opportunity' being created.

The information and communications technology (ICT) industries – including hardware and software, telecommunications networks and service providers, and digital media – constitute the foundation of this digital opportunity. As technologies become more compact and mobile, they are rapidly transforming every sector of the economy, from resource extraction and manufacturing industries to financial services and cultural industries. Some view the digital opportunity only in terms of a discrete set of exciting, but limited, technologies; yet others see it as the fundamental transformation of the competitive basis for entire sectors and regions of the global economy. Arthur (2011) suggests we are on the cusp of a massive shift to a new economy that goes well beyond the use of computers, social media and e-commerce as we transition from physical and mechanical processes to digital and neural ones. Digital technologies are creating the opportunity for a vast array of new products, technologies, services, business processes, societal tools and organizations that will generate new wealth, but also challenge the existing system of production, even our ways of thinking and interacting with the world around us.

In the wake of the rapid onset of this digital transformation, Canada lacks sufficient insight into how to seize the digital opportunity and hence, global competitive advantage. The paucity of current research on the nature of Canadian participation in evolving digital networks leaves a major and worrying gap in the knowledge base needed to form effective policies. In response to this need, the research partners have come together to design a project to produce the knowledge required to move forward. The proposed **Research Partnership on the Digital Economy**, including members at 16 universities and 11 confirmed partner organizations, will work together to fill this gap by answering the question: how can Canada best respond to the challenges posed by a rapidly changing digital landscape, while benefiting from emerging opportunities to promote our economic prosperity? The primary goal of the partnership is to situate Canada's digital opportunity in a global context in order to frame policy that strengthens our international competitiveness and contributes to a broader public debate. The **challenge** posed for this project is to identify where the greatest opportunities and risks lie and propose the most effective policies to secure their benefits for Canada and the future prosperity of Canadians.

2. Context:

The digital opportunity at the heart of this project begins with the immediate and foreseeable direct digital applications – mostly found in the C\$155 billion information and communication technology (ICT) sector; but more importantly, it includes the effect of digital systems on production in traditionally non-digital sectors. Our potential to capitalize on this opportunity is at risk. Canada has enjoyed amazing success in the field of digital technology, but the rapid pace of innovation has weakened the competitive position of some of our leading firms and shifting global leadership is creating new challenges. The centrality of digital technology as a driver of economic growth has made it the focus of recent policy attention, from the 2007 *Science and Technology Strategy* which identified ICT as one of four national priority sectors, to the

consultation on a national strategy for the digital economy, *Improving Canada's Digital Advantage* (Industry Canada 2007, Government of Canada 2010). Other national bodies have also advanced recommendations to support a national digital strategy (Wesley Clover 2008, Council of Canadian Academies 2010, ITAC 2010, ICT Consortium 2010). This is matched by activity abroad, both in the context of the OECD's digital economy program (OECD 2012) and many competing countries (EIU 2010). The limited policy response in Canada to these numerous recommendations means that we are falling farther behind, while digitization continues apace to rapidly transform the global economy.

The Research Partnership on the Digital Economy is a unique collaboration designed to fill this policy gap and stimulate public dialogue on the digital opportunity through well informed research and analysis. It builds on existing partnerships between the academic researchers and the public, private and third sector partners, including the Canadian International Council (CIC), the Canadian Digital Media Network (CDMN), Consider Canada City Alliance, CATA i-Canada, the Information Technology Association of Canada (ITAC), Wesley Clover International, the Centre for Digital Media, Delvinia Corporation, The Impact Group, Industry Canada and the Ontario ministry responsible for innovation policy. It will leverage the applied knowledge and experience of the partner organizations to implement the research agenda, integrating elements of both the Insight and Connection aspects of the SSHRC Partnership Grants program and focusing on two SSHRC priority research areas: the Digital Economy; and Innovation, Leadership and Prosperity. It builds on work by the CIC in assessing Canada's comparative advantages in the global economy, CDMN in promoting the development of digital media in Canada, i-Canada in facilitating the transition to intelligent cities across Canada, Delvinia in understanding the potential of digital opportunities to refine the customer experience and create new business opportunities for Canadian firms, Wesley Clover in creating digital companies and partnerships both in Canada and overseas, and Consider Canada in promoting the economic advantages of our leading cities in the global economy. Based on the previous experience of the team, the time frame selected for the project is five years to allow sufficient time to carry out the project, yet ensure the results remain current.

3. Theoretical Framework and Research Design:

Digital opportunity is driven by the convergence of an integrated set of computer, communications and multimedia technologies based on semiconductors, fibre optics, wireless technologies and software that instantly process and transmit information in digital form (Freeman and Louça 2001, Castells 2009). Long-term prospects for sustained growth in the ICT sector are strong because ICT is increasingly embedded in economic activities and has become "a fundamental part of the economic and social infrastructure" (OECD 2008a, 45). The information technology industry comprises the backbone of the global economy and is one of the key drivers of productivity growth (Jorgenson et al. 2005). A defining characteristic of these technologies is the rapid rate of innovation and productivity increases that have occurred, not only in the industries that produce the hardware, software, components, content, and services used in ICT applications, but also in the sectors that benefit from the adoption and use of these technologies. The explosion of mobile communications, cloud computing, social media and machine-to-machine interaction – the Internet of things – is altering the organization of work and the skills and capabilities required in this new economy (Tapscott and Williams 2010). The ICT sector is so critical for the development of globally competitive economies that most countries

aim to position their ICT industries to fuel post-recession growth (Fransman 2007, Cowhey and Aronson 2009, National Research Council 2012, Breznitz and Zysman 2013).

The rapid pace of innovation in digital technologies is becoming too complex, demanding and costly for individual firms to bear alone. Economic activity is increasingly embedded in complex networks of global, national, regional and local innovation systems. Key elements of these systems include spatially clustered firms, national, regional, and local governments, educational and research institutions, and an array of support institutions. At the global scale, the organizational basis of production and innovation is becoming increasingly decomposed and globally dispersed (Schmitz and Strambach 2009). Decomposition refers to the geographic and organizational recasting of business operations from manufacturing to R&D and business strategy. As a consequence, elements of national and regional innovation networks are linked to elements of other networks to form **global production networks (GPNs)** in which multinational corporations play a key role as system integrators (Chen and Vang 2008, Parilli et al. 2013).

The notion of GPNs, or webs of components, modules, subsystems and service bundles, as opposed to the earlier concept of global value chains, suggests the constant reorchestration and relocation of the components of value creation and the imaginative reintegration of the constituent elements (Sturgeon 2000, Gereffi, Humphrey and Sturgeon 2005). They are altering how firm strategies are designed and implemented (Coe, Dicken and Hess 2008). The most successful firms have built optimal strategies according to the ‘product logics’ of their particular industries. The expanding role of global production networks is contributing to the emergence of large and sophisticated contract suppliers, as well as creating new niche opportunities for smaller firms within these networks. At the same time, the dispersal of innovation activities is resulting in the emergence of a “globally coordinated interactive innovation process” in the form of **global innovation networks (GINs)**. By coordinating the best minds, laboratories, research and ideas on a global basis, leading multinational companies have facilitated the transition to a global innovation system that is grounded in a series of ‘islands of innovation’ dispersed across a variety of geographic locales with strong concentrations of research and knowledge capabilities in both industrial and industrializing countries (Chen and Vang 2008, Cooke 2013).

The ability of new and existing ICT firms, especially smaller ones, to carve out successful niches in these global innovation systems and production networks is critical for their success. The challenge for individual regions and locales is to invest in the appropriate skills and infrastructure and design the appropriate policies that both attracts outside firms and assists local ones to participate in these GINs. At the same time, the extent to which digital technologies are adopted and diffused across a wide range of other sectors is crucial for the future competitiveness of the entire economy. These two major components of the emerging digital opportunity frame the **four research areas** for the partnership project. **First**, it will identify strengths in current and emerging IT sectors by analyzing the place of Canadian companies, products, and services in GPNs and international markets. **Second**, the research will investigate the factors that make specific locales attractive as sites for investment and innovation and enable local firms to connect to GPNs and GINs. **Third**, both a dynamic ICT sector and the deployment of digital tools and processes in traditionally non-digital sectors is essential for an equitable distribution of benefits – nations will not thrive without a balance of the two. This area will investigate how a dynamic ICT sector in Canada can contribute to the adoption and diffusion of digital technologies throughout the broader economy. **Fourth**, the diffusion of these technologies depends, in turn, on the presence of the digital infrastructure in intelligent communities across the country – areas in which Canada appears to be falling behind. This research area will

investigate how the emergence of intelligent communities can create opportunities to deliver new digital products and services to meet a broad cross section of social needs. At the LOI stage, a fifth theme was identified; however, following the comments of the reviewers, this theme has been refocused as part of Research Area 2.

Research Area 1: Canada's Position in Global Production and Global Innovation Networks

What are Canada's competitive strengths in global production networks and global innovation networks and what factors will ensure the future success of Canadian firms?

Canada has long benefited from its privileged access to US firms and US technology and customers, but the critical question for the proposed project concerns Canada's position in the rapidly changing *global* economy and what can be done to expand its *global* footprint in digital technologies. Increasingly, even the most solidly rooted Canadian firms are rethinking the relative balance of research and production in Canada versus the benefits of moving to offshore locations, particularly in Asia. While global production networks are commonly led by US-based multinationals in the global North (Sturgeon 2003), there is rising parity in power and competitiveness. China, Korea and Taiwan, in particular, are emerging as strong competitors. While some see this as a competitive threat, a more forward-looking perspective envisions Asian multinationals leading GPNs. Several Chinese firms, such as Huawei (which is expanding its research base in Ottawa) and Lenovo are close to reaching this status (Breznitz and Murphree 2011). Our Area 1 objective is to investigate how Canadian firms, especially smaller and medium-sized ones, are positioned to create competitive advantage within these dynamic GPNs. Two specific questions motivate the research agenda in this area:

1. How do successful Canadian ICT firms currently position themselves in GPNs and GINs and what factors are likely to make Canada the location of choice for domestic and global firms?
2. How can these factors be effectively harnessed by policy to ensure that Canadian firms participate in these global networks and benefit from the emerging digital opportunity?

Research Area 2: The Local Context for Global Networks

What is the role of local conditions, including local educational and labour market institutions, in supporting the global competitiveness of digital firms in Canada?

As noted above, GPNs and GINs are always grounded in specific geographic locales that form around a unique or differentiated concentration of regional and local assets. Thus, there are competing centripetal and centrifugal forces simultaneously at work at the local, regional and global scales. Local and regional development increasingly depends on the effectiveness of the coupling process that links these regional assets and capabilities with the strategic needs and objectives of the firm-centric global networks (Coe et al. 2004, Parilli et al. 2013). While successful digital firms compete on a global basis, many important inputs to innovation – access to capital, R&D and knowledge creation, and the development of highly skilled personnel – are rooted in a local context. Previous research on the dynamics of the ICT and digital media sectors in Canada confirms that they are embedded in a distinct set of local political and economic spaces across the country (Britton et al. 2009, Lucas et al. 2009). A firm's ability to build global linkages with suppliers and customers is based on its ability both to access local business knowledge and expertise and to tap in into global networks.

Canadian firms are also handicapped by their relatively small size in global terms. The Branham 300 annual survey reports only nine of the 33,000 Canadian ICT companies with revenues over \$1 billion in 2011 were headquartered in Canada (Anderson 2012). The future

prospects for the sector depend on the economic success of relatively smaller firms in a second tier, but their growth is handicapped by the absence of large flagship firms to act as guides into the international marketplace and serve as incubators and training grounds for the managerial talent needed to take these firms to the next level of global competition (ITAC 2010). This research area will investigate the conditions which link GPNs and GINS to these distinct local contexts and support the growth of smaller domestic firms into globally competitive ones.

A critical element in determining the vitality of local and regional contexts for ICT firms is the strength of local labour markets. Previous research and policy documents underline how a highly skilled workforce helps the ICT sector in driving growth and innovation. *Improving Canada's Digital Advantage* stated that talent or skilled human capital is “one of the main sources of available leverage for improving digital advantage” (Government of Canada 2010, 5). A critical issue for the research partnership concerns the role of local educational and labour market training institutions in ensuring an appropriate supply of the skilled labour needed to support local concentrations of digital firms and the provision of skills necessary for the adoption and diffusion of digital technologies throughout the economy. The key research questions are:

1. What are the factors that most effectively shape a local context that is attractive to GPNs and GINs and are conducive to the growth of digital firms in Canada? How can these factors be shaped to help grow Canadian firms to global scale?
2. To what extent are local education and training systems across the country positioned to meet the future demand for digital skills and how can they be improved to support the growth and competitiveness of Canadian firms?

Research Area 3: Diffusion of Digital Technology across The Economy

How does the diffusion of digital technology across all sectors of the economy contribute to the overall dynamism and competitiveness of the Canadian economy?

Digital technologies are playing a transformative role in the reconfiguration of virtually every sector of the economy. Thus seizing the digital opportunity means ensuring that the demand for, and adoption of, digital technologies is strong both in those sectors that produce the technologies and a wide range of but in a wide range of resource, manufacturing and service industries that use them. Firm boundaries are changing as product and services, production and supply are reconfigured on both an organizational and locational basis. Hence, the dividing line between digital and non-digital products or firms is rapidly disappearing; the critical issue is where digital value will be created or threatened (Zysman and Newman 2006, Brynjolfsson and Saunders 2010). Those industry sectors that have made relatively low use of digital technologies are most at risk of being destabilized by the low marginal cost of digital inputs into traditional processes.

Digital technologies are rapidly transforming manufacturing in industries such as steel and autos by reconfiguring the domestic industry into global production networks. As a result, knowledge management capabilities have become strategic assets for the new global steel companies. Digital media applications play a pervasive role in capturing tacit knowledge in production and in transferring that knowledge into the architecture of the new production system (Warrian and Mulhern 2009, Warrian 2012). The growing integration of digital technology with mechanical processes promises even more revolutionary changes. The convergence of advanced industrial systems with low cost sensors, the rapid adoption of data analytics and advanced computing techniques is giving rise to the “Internet of things” that is transforming a diverse array of existing industries, including agriculture, fishing, forestry, mining transportation, energy transmission and oil and gas development (Evans and Annunziata 2012).

In addition, digital technologies are dramatically altering the nature of the service sector, from retail and wholesale to financial and business services. Knowledge-intensive business services rely on the extensive operational and strategic support of ICT as an enabler of information and data processing, as well as the interfacing with clients. The further deployment of mobile platforms, cloud computing, data analytics and social media is accelerating this trend (van Ark, Broersma and den Hertog 2003, Wolfe et al. 2011).

Understanding the full implications of digital technologies for Canada's growth prospects requires an analysis of its impact on a broad cross-section of industries that are being transformed through these developments. This research area will examine the trends and emerging gaps in a number of strategically-important, globally-competitive, and increasingly trade-interdependent Canadian industries (e.g. mining, grains and oilseeds in the primary sector, steel, automobile, transportation equipment in the manufacturing sector; retail, wholesale, and business services in the service sector) with a focus on the digital opportunities for rural and remote areas. The key research questions are:

1. How effectively are industries in the resource, manufacturing, service sectors in Canada adopting and deploying new digital technologies and media applications? What opportunities, both global and domestic, is this creating for domestic suppliers of digital products and services?
2. What policy initiatives are needed to ensure that Canadian industry remains at the forefront of ICT adoption and diffusion?

Research Area 4: The Role of Digital Infrastructure in Building Intelligent Communities

How effectively is the deployment of digital infrastructure contributing to the building of intelligent communities across the country and to our economic performance?

The fourth research area focuses on the state of Canada's digital infrastructure and the contribution it is making to the creation of intelligent communities in cities across the country. The role of broadband infrastructure has evolved significantly as a content distribution platform leading to greater recognition of the critical role it can play in delivering new products and services in a wide range of fields. More significantly, digital infrastructure is now recognized as the prerequisite for transforming cities and regions into intelligent communities, defined as incorporating broadband connectivity, innovation capability, a knowledge-based workforce, digital inclusion, marketing and advocacy. Despite Canada's early lead in expanding digital infrastructure, we have begun to lag behind other developed nations. Harvard University's Berkman Center study on global broadband practices ranked Canada 19th worldwide in Internet access. It noted that Canada faces an enduring gap in urban-rural coverage and that Internet Service Providers (ISPs) have been slower to deploy wireless and fibre technologies (Benkler et al. 2010). Understanding how to transform Canadian cities into intelligent communities can help create new economic opportunities and contribute to growth prospects across the country. Working closely with our partner i-Canada, which is engaged in conducting community audits across the country and benchmarking intelligent communities, the members of the research team will investigate the following questions:

1. To what extent Canadian communities in all regions of the country are using digital infrastructure to become intelligent communities, employing e-health, e-work, e-commerce, e-education and e-government to create digital opportunities for all citizens?
2. What measures could best support their efforts to become intelligent communities?

4. Main Research Methods

The research team assembled for this project has expertise in a wide range of methods for data collection and analysis (see Participants Involvement). Working closely with our partners and the unique data sources they have access to, the team will use both quantitative and qualitative methods to pursue the research agenda. Several members of the team are skilled in a range of econometric techniques, Input-Output modeling, and spatial and relational mapping, such as social network analysis. This quantitative analysis will provide an important starting point to frame the qualitative research. While the both aspects of the project will proceed in tandem, we will use the analysis of quantitative data to provide a broad overview of the relevant trends in all four research areas and to frame the issues to be probed more deeply through the comparative case study method of the qualitative analysis. For example, we will use the data from the Survey of Innovation and Business Strategy (SIBS) to find out what kind of activities are being carried out by Canadian firms and locate them in specific positions within GPNs. We will then use the comparative case studies to probe more deeply as to why Canadians excel in those niches of production. Several members of the team have previously used this complementary approach with great success. **Table 1** provides an overview of both the quantitative and qualitative methodologies that will be used to investigate all four research areas.

Table 1

Research Theme	Methodologies	Examples of Data Sources	Role of Partners
Area 1: Global Production Networks	Quantitative - Econometric Analysis - Relational mapping using IO and firm data - Social Network Analysis	- Local IDEAs Database - Survey of Innovation and Business Strategy (SIBS) - Input-Output Datasets - Other Surveys	- Facilitate Access to Data - Provide insights of how data links to decision making - Engage in qualitative assessment of data
Area 2: Local Context	Qualitative Comparative Studies of Industries and Communities: - Mapping of GPNs from global to local level - Digital adoption by industry sector - Audits of Intelligent Communities	Interviews and focus groups with key informants: - Companies and Investors - Industry and Community Associations - Local, regional and national governments - Institutes of High Education - Public Research Facilities	- Contribute to research tools and analysis - Provide researchers with proprietary reports - Facilitate focus groups among partner’s members - Facilitate research meetings using proprietary communications platforms
Area 3: Diffusion of Digital Technology			
Area 4: Intelligent Communities			

Multilevel Quantitative Analysis: Through our partnership with Industry Canada, the researchers will have access to the results of the 2009 SIBS, a joint project by Industry Canada, Foreign Affairs, Trade and Development Canada and Statistics Canada, which was conducted to better understand the market and policy factors that influence the adoption of entrepreneurial and innovation-oriented business strategies. The survey provides information about global production network management practices, offering insights into which activities businesses relocate to other countries and which are outsourced to external suppliers. Statistics Canada is currently in the field with a new SIBS survey which will become available during the project to provide the basis for a comparative analysis of changes over time. The project will also utilise a series of multi-country input-output datasets constructed by Wixted (2009), as well as the freely

accessible World Input-Output Database (WIOD) for all years 1997-2009 (WIOD 2012). The analysis of these datasets allows us to conduct production network analysis at the industry level, which is difficult to do using trade data alone. The analysis of these various datasets allows us to investigate GPNs at the industry and product levels in their local, regional, and national contexts.

In addition, the project will undertake extensive analysis of the ICT sector and the digital economy in Canada using Local IDEAs, a unique database of economic indicators developed at the Munk School with funding from the Canada Foundation for Innovation, the Ontario Research Fund and private sector partners. Local IDEAs includes data on global corporate linkages that will enable the team to situate Canadian ICT and digital media firms in their GPNs. The database will also be used to provide detailed analyses of the relevant socio-economic characteristics of a wide range of Canadian industries and communities to frame the context for the data to be collected through the qualitative phase of the research. We will use the analysis of the SIBS/Local IDEAs data to help select the key informant interviewees and frame the questions for our case study participants, across all four research areas.

Comparative Case Studies of Industries and Communities: The project will include case studies conducted in key segments of the ICT, resource, manufacturing and service sectors in Canada. The case studies will probe how GPNs and GINs are being transformed overseas, particularly in East Asia, and identify where the greatest opportunities for Canada are emerging. The application of qualitative case study methods will complement and deepen the quantitative analysis through the use of structured interviews with key representatives of firms, including founders, investors, executives, and skilled workers in the ICT, resource, manufacturing and service sectors, as well as community support organizations, economic development agencies, financial services, and educational and research institutions. We will use the results of the structured interviews to: 1) map the actual and potential position of Canadian firms and research centers within GPNs and GINs; 2) understand the factors determining the competitive strengths of local communities in the digital space; 3) study the pace of adoption of digital technologies across a range of industries; and 4) map the transition to intelligent communities.

Working with our partners at Industry Canada, Ontario's Ministry of Economic Development, Trade and Employment, and the Science, Technology and Innovation Council, team members will have access to non-classified government studies and background reports on the current state of the ICT sector and the pace of adoption of digital technologies across other industries and sectors in the economy. The identification of prospective interviews in all four research areas will be facilitated by the branch network of the CIC, the network of organizations that comprise the CDMN, ITAC, and targeted focus groups organized in cities across the country by Consider Canada, i-Canada and companies that are part of Wesley Clover.

5. Conclusion

Digital technologies are rapidly changing the world we live in, whether by facilitating the restructuring of business into more effective GPNs and GINs, or by improving the productivity of businesses applying digital tools in their operations, and providing better opportunities to digitally connect communities. However, these developments do not automatically bestow their benefits upon all businesses or nations equally. We need to better understand how Canadian ICT firms, digital media content producers and technology users can most effectively participate in the rapidly expanding global digital economy. Without a clearer understanding of how Canada can benefit from these changes, based on solid research, business, governments and communities will lack the information needed to develop effective strategies for Canada's digital future.