

# **Proposal for a Canadian Innovation Testbed**

Addressing a Critical Gap in the Canadian Innovation System

Submitted by:

CANARIE, Inc.

Dr. David Plant, McGill University

Dr. Alberto Leon-Garcia, University of Toronto

Dr. Rob Simmonds, University of Calgary

July 5, 2010

## Executive Summary

CANARIE and several prominent Canadian researchers in ICT are responding to Industry Canada's Digital Economy Strategy (DES) consultation.

Canada has shown a decline in innovation and productivity as compared to other developed nations, as reported by the Canadian Council of Academies and the Organization for Economic Cooperation and Development. Access to an environment which emulates real-world conditions and would allow Industry, SMEs, researchers, digital content creators and those who are part of the Canadian Innovation ecosystem to develop and test out prototypes, concepts, products and services is **the missing link** in the Canadian innovation system and a critical enabler of accelerated ICT product and service commercialization.

The Innovation Testbed is such an environment. While it shares much of the existing physical CANARIE network, the Testbed traffic is isolated from the CANARIE production traffic using advanced virtualization techniques. It contains a multitude of technologies such as advanced high speed networks and next generation (LTE) wireless networks, storage and computing resources, various sensors and tools. Virtual slices of this foundational environment would be allocated to those requiring it to advance the creation of next generation "smart technologies", such as smart IT networks, smart buildings, smart cars, smart energy grids and smart cities. It is a relatively cost-effective method that leverages some existing infrastructure and ongoing government investments to provide Canadian innovators with an environment to develop and test a multitude of innovative digital applications.

The benefits of this environment are multiple and wide ranging. It would speed the creation and investments in new technologies as well as the transfer of research to the commercial marketplace. As other jurisdictions have such an environment, it would place Canada on a competitive footing in the race to global market leadership in ICT industries. It would provide Canada with a globally competitive digital infrastructure for development of highly qualified personnel (HQP) as well as a compelling reason for foreign Multi-National Enterprises to fund development activities in Canada.

The Innovation Testbed would become an integral part of the Canadian ICT innovation system, permitting collaboration and partnerships among innovation system stakeholders, including funding agencies, universities, government labs, non-profit organizations as well as stakeholders from the private sector including Industry, startups, SMEs and Venture Capitalists. New collaborations will likely arise as the Testbed becomes the incubator where shared data and expertise lead to the development and testing of innovative products and applications.

Through the expanded use of the existing CANARIE network, the Government has the power to harness the intellectual capital of a wide range of scientists, developers, graduate students and

private sector innovators in an environment in which digital creativity, collaboration, and commercialization can flourish.

**CANARIE is committed to working with the Government to ensure Canada's highly qualified personnel have an opportunity to use their intellect and creativity to drive economic and social benefits for all Canadians.**

## **Introduction**

Several recent reports on Canadian innovation, including one from the Council of Canadian Academies, have indicated Canada lags behind other countries in spurring innovation despite significant investments in science, technology and innovation. One of the overarching reasons cited for Canada's poor performance is its inability to successfully translate research into commercial products and services.

Looking at other major economies, it becomes apparent that one of the key requirements for growth in the new knowledge economy is an integrated digital infrastructure that permits rapid transfer of knowledge seamlessly among stakeholders in the innovation system. An international survey, conducted in April 2010, showed that all leading information and communication technology-based nations, particularly Japan, South Korea, the European Union, and the USA, already have test platforms for innovation, namely Akari, KGENI, Fire and GENI. These and other jurisdictions already have ambitious, nationally supported Information and Communications Technology (ICT) and Digital Economy Future programs which are motivated by sustaining or growing market share in the future Internet economy.

A critical gap in the current digital infrastructure identified by Canadian researchers and academics is a "Canadian Innovation Testbed" (Innovation Testbed). This gap can be dramatically narrowed by leveraging existing digital infrastructure (CANARIE). Addressing this gap would offer an integrated approach that stimulates Canadian innovation while facilitating commercialization of research, and strengthening the research capacity of academics, researchers, graduate students and private sector innovators. More innovations will lead to creation of new world-leading businesses which in turn will create new skilled jobs in Canada, contributing to overall economic growth.

## **What is an Innovation Testbed?**

The proposed platform is an incremental extension of the existing network that would utilize advanced virtualization techniques to offer an at-scale experimentation and development environment for advancement of digital technologies. Multiple instances of distinct virtual high scale/performance networks can be created to support experimentation and testing in new settings, e.g. gathering sensor information, leveraging cloud computing, or interconnecting vehicular networks. Experimentation instances can operate independently, in total isolation, or can interoperate as autonomous systems which model the current Internet. Canadian researchers and developers will have the advantage of a world class platform to accelerate development and commercialization of "smart" technologies, including next-generation Internet technologies for smart buildings, smart cars, smart energy grids, smart cities, and smart IT networks, as well as wireless technologies, and green technologies.

The Innovation Testbed is a unique opportunity to leverage existing digital infrastructure to offer an incubation platform for the research and development needs of innovators in the

public and private sectors. Undergraduates will have access to the testbed facilitating development of Canada's highly qualified personnel. It would serve to attract foreign researchers to Canada to test and apply their research in an at-scale digital environment.

The proposed platform will help facilitate growth in the key economic areas identified in the federal Science and Technology Strategy: (a) Environmental science and technologies, (b) Natural resources and energy, (c) Health and related life sciences and technologies, (d) Information and communications technologies, by building on progress already made and accelerating commercial opportunities. It will bring together expertise and provide access to the state-of-the-art digital infrastructure required to investigate, implement and perform large scale testing of clean energy, medical, wireless and other technologies.

## Who Benefits?

Some of the key macro-level benefits of the testbed include:

### *For Canada:*

- **Targets International ICT R&D priorities**
  - Addresses the following 4 internationally recognized ICT R&D priorities directly:
    - Computing systems and architectures
    - Network infrastructures
    - Digital content technologies
    - ICT and Internet security
  - Supports, indirectly, the remaining 4 of the 8 international ICT R&D priorities:
    - Physical computing foundations
    - Converging technologies and scientific disciplines
    - Software engineering and data management
    - Human-technology interfaces
- **Accelerates technology transfer**
  - Increases the ROI of research funding by providing a collaborative environment for researchers and industry that leverages an at-scale production environment to validate commercial viability of scale and performance in order to reach ????
- **Spurs the development of new digital content**
  - Incentivizes investment in the digital content domain by providing a platform for digital content creators to experiment with new content delivery mechanisms (e.g. new compression algorithms using cloud computing over future Internet). The platform will facilitate development of talent in this area by providing "hands on" training to researchers and application developers who are experimenting with new delivery and business models. Private sector investments will be more likely to flow to services and applications that have been proven through the Innovation Testbed.

- **Spurs the development of mobile applications**
  - Stimulates the growth of a mobile applications development community and reinforces Canada’s mobile communications industry by providing a Future Internet platform where the default access is mobile and wireless.
- **Develops ICT skills and Highly Qualified Personnel (HQP)**
  - Facilitates the development of HQP that is attuned to future ICT needs by providing an infrastructure that can be used in the classroom and by graduate student researchers to explore and test new applications. The Innovation Testbed provides these students with critical “hands on” experience with a large scale testing platform that includes storage, computing and networking capabilities.
- **Increases Canada’s capacity to innovate using digital technologies**
  - Offers an environment for researchers and application developers to test their projects in the pre-commercial stage. Supports “Government as model users” by providing Governments with exposure to new and innovative ICT tools that can be incorporated into Government ICT systems. The Innovation Testbed will also offer a platform to test and develop new security tools and algorithms, improving cybersecurity for the future Internet.
  - Encourages ICT researchers to stay, reinforce their presence and innovate in Canada by providing access to the resources required to conduct cutting-edge research on a leading-edge platform.
- **Facilitates partnerships among innovation system players**
  - Provides an opportunity to form partnerships among innovation system stakeholders to collaborate on projects and bring focus to specific research investments.

***For Industry:***

- **Attracts Multinational Enterprise R & D investment**
  - Provides incentives to multinational enterprises (MNEs) to conduct cutting-edge digital research in Canada, and to base operations in Canada. A stronger MNE presence will also help draw Foreign Direct Investment (FDI) and HQP to Canada from around the world.
- **Focuses research on proven product platforms**
  - Provides a platform where ecosystems can emerge around particular products (e.g. RIM, Ericsson, CIENA or Alcatel-Lucent products) and encourages SMEs to use the testbed to test and develop products that operate with future

applications, thus supporting product development for vendors that have a well-established customer base.

- **Makes Canadian digital innovation investments less risky for venture capitalists**
  - Reduces risk for venture capitalists to invest in Canadian SMEs, as SME offerings will have been tested at-scale and are thus closer to actual deployment.
- **Grows the ICT sector**
  - Provides an incubation platform on which small ICT firms and other SMEs can launch their new product ideas and leverage their intellectual assets to create value. It can also remove barriers to innovation associated with these players not having the resources to build sophisticated internal IT infrastructures.
  - Allows SMEs to focus their research efforts on leveraging value creation through more innovative products and services while avoiding the early-stage activities that consume time and money, such as the creation of a research and development environment.

### *For research and academia:*

#### **Expands Canada's intellectual capital**

- Provides an integrated environment where basic, advanced and applied research can be conducted and validated. Canadian researchers and HQP will be incented to remain and innovate in Canada because of the availability of a robust research environment that mirrors the real-world environment.

#### **Maximizes existing digital infrastructure investments**

- Reduces expenses required for build out of IT infrastructure for academic institutions as the testbed can support multiple virtual environments.

### **Supports a Range of Innovation**

The testbed will become an integral part of the Canadian ICT innovation system, permitting collaboration and partnerships among innovation system stakeholders, including funding agencies, universities, government labs, non-profit organizations as well as various stakeholders from the private sector including Industry, startups, SMEs and Venture Capitalists. New collaborations will likely arise as the testbed becomes the incubator where shared data and expertise lead to the development and testing of innovative products and applications.

Innovation may be classified in several ways. The proposed Innovation Testbed will facilitate product and service innovation, process innovation, and paradigm innovation, as follows:

- **Product/service innovation**
  - This type of innovation broadly involves the creation of new or improved products and services. The testbed will enable researchers and developers to test and deploy new network protocols, services and applications. For example, users could test a new cloud-based video streaming service that would use a new video compression algorithm over future Internet protocols to offer lag-free real-time video to consumers.
  
- **Process Innovation and Smart Infrastructures**
  - This type of innovation involves devising more effective and efficient ways to accomplish desired outcomes. A well-known example of a process innovation is just-in-time supply chain methodology. The testbed will provide researchers with the capacity to experiment with large and complex process innovations designed to deliver increased efficiency. For example, a more efficient Enterprise Resource Planning (ERP) system could be tested and initially deployed for the automotive industry, which works with thousands of suppliers for a single product. Smart infrastructures represent a major class of new innovations where ICT will enable very large scale management systems for smart buildings, smart transportation systems, and smart power grids.
  
- **Paradigm Innovation**
  - This type of innovation involves changing the thinking behind the usage of a product or service (e.g. mainframe to pc, cellphone to smartphone). The testbed will provide the environment for users to test new business paradigms including, for example, innovative content delivery mechanisms and business models. An example would be a new service providing a real-time telemedicine application to a smartphone using the next-generation wireless protocol.

## **Why does Canada need an Innovation Testbed?**

Canada has shown a decline in innovation and productivity as compared to other developed nations, as reported by the Canadian Council of Academies and the Organization for Economic Cooperation and Development. The innovation testbed is a relatively cost-effective method for leveraging existing infrastructure to provide Canadian innovators with an environment to develop and test innovative digital applications. The need for the testbed has already been identified by researchers as one the key “missing links” in the Canadian innovation system. Currently, when Canadian researchers need to experiment at-scale with new complex applications (e.g. cloud computing), they have to rely on commercial services, which are mostly offered by US-based providers. As a result, if a professor at the University of British Columbia wants his students to develop and test cloud computing-specific applications, he has to “rent” cloud computing facilities for his students from a commercial provider and pay a premium price for limited testing capabilities.

Canadian SMEs, with limited R&D budgets, are faced with the same issue if they wish to test new service offerings at-scale. Inability to conduct large scale testing of their applications in Canada and the high cost of using commercial services are major disincentives for research and development of next-generation applications and services. The absence of a Canadian innovation testbed could lead to a weakening of Canada's competitive advantage against emerging countries (e.g. China and India), and result in a decline in overall economic growth.

If developed, the Innovation Testbed would position Canada as an ideal business and investment environment for ICT and other digital industries. The testbed could become a major attraction for global HQP to conduct research and test applications. Multinational companies, who currently conduct most of their R&D activities outside of Canada, will be incented to set up R&D operations in Canada as they will have access to a globally unique environment for new product development. Smaller firms will gain access to a robust at-scale digital environment that would allow them to fully leverage their creative and intellectual capital and overcome systemic barriers to digital product and service development and deployment.

## **How does the Innovation Testbed align with the Digital Economy Strategy?**

Industry Canada's Digital Economy Strategy (DES) consultation paper identified five major categories that Canada needs to address to ensure future economic growth and prosperity for Canadians. The five categories are:

1. Capacity to Innovate Using Digital Technologies
2. Building World-class Digital Infrastructure
3. Growing the Information and Communications Technology Industry
4. Creating Canada's Digital Advantage
5. Building Digital Skills for Tomorrow

For each of these categories, there were specific challenges identified in the current Canadian context. The testbed aligns with Canada's current priorities as it will address many of the objectives and challenges identified in the DES consultation paper.

Industry Canada – Digital Economy Strategy Consultation objectives and challenges		Canadian Innovation Testbed
<b>Creating Canada’s Digital Content Advantage</b>	Investments	√
	Talent and Sector Development	√
<b>Building Digital Skills for Tomorrow</b>	Skills Shortages in ICT	√
	Improving Digital Skills in Workplaces	√
	Narrowing Digital Skills Divide	√
<b>Capacity to Innovate Using Digital Technologies</b>	Overcoming Underinvestment in ICT	√
	Government as Model User	√
	Protecting the Online Marketplace	√
<b>Growing the Information and Communications Technology Industry</b>	Technology Innovation	√
	VC Financing	√
	Talent	√
	Government as a Model User	√

## Driving a Robust and Prosperous Digital Economy

Canada has a compelling opportunity to leverage existing digital assets to drive an unprecedented level of digital innovation and creativity. Through the expanded use of the existing CANARIE network, the Government has the power to engage a wide range of scientists, developers, graduate students and private sector innovators in an environment in which digital creativity, collaboration, and commercialization can flourish. The benefits are multiple and wide-ranging, the user communities are ready, and CANARIE is committed to working with the Government to ensure Canada’s highly qualified personnel have an opportunity to use their intellect and creativity to drive economic and social benefits for all Canadians.

## Appendix A

### About CANARIE Inc.

CANARIE Inc. is Canada's Advanced Research and Innovation Network. Established in 1993, CANARIE manages an ultra high-speed network, hundreds of times faster than the internet, which facilitates leading-edge research and big science across Canada and around the world. More than 40,000 researchers at over 300 Canadian universities and colleges use the CANARIE Network, as well as researchers at institutes, hospitals, and government laboratories throughout the country. The CANARIE Network enables researchers to share and analyze massive amounts of data, which can lead to ground-breaking scientific discoveries. CANARIE's network, programs, and strategic partnerships with 12 regional networks in Canada, and 100 international networks in more than 80 countries, stimulate research that **delivers economic, social, and cultural benefits to Canadians.**

CANARIE is a non-profit corporation supported by membership fees, with major funding of its programs and activities provided by the Government of Canada. For additional information, please visit:

[www.canarie.ca](http://www.canarie.ca).

### About Professor Alberto Leon-Garcia, University of Toronto

Professor Alberto Leon-Garcia is Professor in Electrical and Computer Engineering at the University of Toronto. He is a Fellow of the Institute of Electronics and Electrical Engineering "For contributions to multiplexing and switching of integrated services traffic". He is also a Fellow of the Engineering Institute of Canada. He has received the 2006 Thomas Eadie Medal from the Royal Society of Canada and the 2010 IEEE Canada A. G. L. McNaughton Gold Medal for his contributions to the area of communications. He holds a Canada Research Chair in Autonomic Service Architecture.

From 1999 to 2002, he was founder and CTO of AcceLight Networks in Ottawa which developed an all-optical fabric multi-terabit, multiservice core switch. He holds several patents and has published research extensively in the areas of switch architecture and traffic management. Professor Leon-Garcia's current research interests are focused on application-oriented networking and autonomic resources management with a focus on enabling pervasive smart infrastructure. His research team is currently developing a network and applications testbed that will enable at-scale experimentation in new network protocols and distributed applications.

Professor Leon-Garcia is recognized as an innovator in networking education. In 1986, he led the development of the University of Toronto - Northern Telecom Network Engineering Program. He has also led in 1997 the development of the Master of Engineering in Telecommunications program, and the communications and networking options in the undergraduate computer engineering program. He is author of the leading textbooks: *Probability and Random Processes for Electrical Engineering*, and *Communication Networks: Fundamental Concepts and Key Architecture*

### About Professor David Plant, McGill University

David V. Plant received his Ph.D. degree in electrical engineering from Brown University, Providence, RI, in 1989. From 1989 to 1993, he was a Research Engineer at the Department of Electrical and Computer Engineering, University of California at Los Angeles (UCLA). He has been a Professor and Member of the Photonic Systems Group, the Department of Electrical and Computer Engineering, McGill University, Montreal, QC, Canada, since 1993, and Chair of the Department since 2006. He is the Director and Principal Investigator of the Center for Advanced Systems and Technologies Communications at McGill University. His research interests include optoelectronic-VLSI, analog circuits for communications, electro-optic switching devices, and optical network design including OCDMA, radio-over-fibre, and agile packet switched networks. Dr. Plant has received five teaching awards from McGill University, including most recently the Principal's Prize for Teaching Excellence. He is a James McGill Professor and was an IEEE Photonics Society Distinguished Lecturer. He was the recipient of the R.A. Fessenden Medal and the Outstanding Educator Award, both from IEEE Canada, and received a NSERC Synergy Award for Innovation. He is a member of Sigma Xi, a Fellow of Optical Society of America, the Institute of Electrical and Electronics Engineers, the Canadian Academy of Engineering, and the Engineering Institute of Canada.

About Dr. Rob Simmonds, Research Director, Grid Research Center, University of Calgary

Dr. Rob Simmonds received his BSc and PhD degrees from the School of Mathematical Sciences at the University of Bath in 1994 and 1999 respectively. He is currently research director of the Grid Research Centre at the University of Calgary and holds an Adjunct Associate Professor position at in the Department of Computer Science at the University of Calgary. In addition Dr. Simmonds has been Chief Technology Officer for WestGrid, which is one of the seven consortia that form Compute Canada and is on Compute Canada's technical group (TECC) steering committee.

Dr. Simmonds has performed research in areas including parallel discrete event simulation, parallel network emulation, grid computing, utility computing, cloud computing and the use of social networking technologies to create research computing environments. He has over 45 refereed conference and journal publications and been a participant in 5 CANARIE projects. In addition Dr. Simmonds collaboration with HP Labs in the area of model driven automation for utility computing led to the donation of a \$4M computer system to the University of Calgary.