Canada

Innovation by Design

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I. Introduction

Canada, located in North America, is the second largest country in the world, with a total area of 9,984,670 km^2, and spanning from the Atlantic to Pacific oceans. Comprised of ten provinces and three territories, Canada has a total population count of 33,476,688 people.

Canada is one of the top 10 trading nations, with the 11th largest economy in the world. With this economic standing, Canada spends on average $29.9 billion annually on domestic research and development (R&D). This has led to the production of 14 Nobel laureates, a global 4th place ranking in scientific research quality, and a 1st place ranking in proportion of college-educated adult residents in the world [1], which is attributed to the large number of post-secondary educational facilities, including 72 universities and over 200 colleges.

II. Chip Design and EDA presence

Canada's high-tech sector covers the range of technology fields and application areas. As of 2011, CMC Microsystems has identified 355 organizations based in or which have offices located in Canada, and are also involved in the various areas of the chip design supply chain, including EDA, fabrication, design, and so on [2]. The top Canadian industrial members in the chip design/EDA fields include Blackberry and Celestica. The Canadian fabrication and manufacturing ecosystem includes various companies and organizations, such as Teledyne DALSA, Micralyne, C2MI and ACAMP.

III. Academia

The infrastructure for microelectronics and microsystems research in Canada is contained in the National Design Network (NDN), a collaboration between 50+ academic institutions and a number of industrial participants across Canada involved in microelectronics and microsystems research and development. This network is managed by CMC Microsystems [3], a not-for-profit organization aimed to enable and accelerate microsystems R&D in Canada. Through the NDN, CMC Microsystems oversees the acquisition and delivery of world-class products and services covering the microsystem development flow from concept to proof-of-concept, including microelectronics, microelectromechanical systems (MEMS), microfluidics, photonics and embedded system technologies [4-6]. This flow covers the design, make and test of microsystems.

In the "design" space, CMC Microsystems, through the NDN, provides CAD tools, process design kits (PDKs), development systems and design methodologies to cover all aspects of microsystem development. The CAD tools provided cover all the aforementioned component technologies and are supplied from vendors world-wide. Access to this collection of design software is made possible nationally via the License Management System, established by CMC Microsystems, to provide quick and seamless access to the NDN for academic research in the microsystem area. The PDKs share compatibility with the CAD tools available through the network, as well as map to the fabrication technologies used by members of the NDN. The development systems include a number of platforms, both developed in-house and acquired through vendor partnerships, for the co-development of embedded software and microsystems hardware. The methodologies provided are both industry-based and in-house developed flows, covering the design steps necessary for successful chip designs, and targeting the design environment available through the NDN.

Capital	Ottawa
Largest city	Toronto
Languages	English, French
Area (Total)	9,984,670 km^2
Population (2012 estimate)	33,476,688
Currency	Canadian dollar ($) (CAD)
Time zone	**(UTC -3.5 to -8)**
Internet TLD	.ca

In the "make" space, the NDN provides access to fabrication, assembly and packaging technologies and services through partnerships with vendors around the world. Fabrication through the NDN is also managed by CMC Microsystems and includes in-house physical verification of designs submitted, access to a number of microsystem technology fabrication facilities, as well as the establishment of the Micro-Nano Technologies Facilities portal, which organizes access to a number of academic fabrication research facilities across Canada. Similarly, packaging and assembly services are provided for the further integration of microsystem technologies for complete development of devices. Finally, the "test" phase of microsystem proof-of-concept development includes access to a number of test equipment and facilities across Canada, as well as developed reference documentation, for efficient and accurate verification.

IV. Government Programs

The primary government funding organizations supporting the academic and industrial arms of the NDN are the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Canada Foundation for Innovation (CFI). Coupled with these organizations are the individual provincial and territorial governments, each of which provides monetary support to the NDN along with the aforementioned federal support.

In terms of technology applications, both NSERC and the National Research Council Canada (NRC) have mandates to advance science and technology objectives in Canada, including, but not limited to [7]:

- Information and Communication Technologies
- Biotechnologies
- Energy and Environmental Technologies
- Sustainable Energy Systems
- Safety and Security

The enabling technologies for each of the identified target application areas of Canadian high-tech research and development include nanoscience/engineering, materials science, photonics, microfluidics, quantum information, MEMS, microelectronics and embedded software/systems. The enabling and acceleration of research in each of these technologies and their application spaces are made possible through the activities of the NDN, and the federal and provincial government funding to this network, managed by CMC Microsystems.

Canada also aims to increase the development of high-tech business by focusing on five key strategic areas, as identified by Canada's Science, Technology and Innovation Council (STIC) [8]:

- Business Performance of Research and Development (BERD) as a share of GDP
- Business investment in Information and Communications Technologies
- Higher education expenditures on Research and Development (HERD) as a share of GDP
- Science and engineering doctoral degrees granted per 100,000 population
- Share of human resources in science and technology

A number of other government initiatives also exist to provide incentive into the research and commercialization of science and technology-based products and services, including the Scientific Research and Experimental Development Program, the Industrial Research Assistance Program, and the Canadian Innovation Commercialization Program.

References

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[3] CMC Microsystems (www.cmc.ca).

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[7] Microsystems: Creating Economic Value for Canada, A National Design Network Proposal, April 2009.

[8] STIC - Science, Technology and Innovation Council_ Aspiring to Global Leadership (http://www.stic-csti.ca/eic/site/stic-csti.nsf/eng/00076.html).

Dr. Hisham El-Masry received his B. Eng (1999), Masters (2001), and Ph.D. (2013) degrees in Electrical and Computer Engineering from Dalhousie University, the University of Toronto and the Royal Military College of Canada; respectively. He was the IEEE Kingston Section Chair for 2004 and 2005, for which he received the IEEE Regional Activities Board Achievement Award in 2006. He was also a member of the International Cadence Usergroup Committee from 2002 to 2004. He joined CMC Microsystems in 2001 where he is currently a Mixed Signal Design Engineer. His primary areas of research include the design, simulation and development of design methodologies for microsystem integration.