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Can Embedded Systems be at the Heart of New Zealand's Knowledge Economy?

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I. Introduction

New Zealand (NZ) is a culturally diverse, nation, which is part of the OECD. It is comprised of two main islands, summing up to a total land area of 268,680 km^2, and a population of around 4.5 million. NZ is located some 1500 km east of Australia across the Tasman Sea.

New Zealand has been recognized as one of the most politically stable, well-governed countries in the world. The Mercer Quality of Living Survey consistently ranks prominent cities as the top 10 livable cities in the world [1]. According to Transparency International [2], NZ is ranked first based on government transparency and the lack of corruption, and fifth considering the strength of its democratic institutions [3]. The report also states that NZ exhibits promising opportunities for business start-ups as evidenced in the 2013 Ease of Doing Business Index [4], which places NZ overall third and first in the sub-category of Starting Business and Protecting Investors respectively.

As a primarily agrarian economy, nearly a quarter of NZ's produce is exported overseas to destinations such as USA, Japan, China, Australia and the UK. One of the most notable companies in NZ, Fonterra, controls one-third of world's international dairy trade [5]. Science, engineering, research and development is also at the forefront of NZ's ethos. Noteworthy Nobel laureates include Ernest Rutherford, Maurice Wilkins, and Alan MacDiarmid.

II. Information Communcation Technology

New Zealand is a country of design and innovation. Many new ideas, inventions and revolutionary manufacturing practices have contributed to world leading companies that emerged in the ICT sector. Some of the well-known exponents of these are Weta Digital, Rakon, Endace, NextWindow, Orion Health, and Glidepath.

Weta Digital is visual effects company responsible for various blockbuster films such as The Lord of The Rings trilogy, King Kong and Avatar. The company has been awarded a number of Academy Awards for its innovations in the area of 3D visual effects. Rakon is a globally competitive company in telecommunications, positioning, aerospace and defense. The company is a world leader in innovation, design and production of highly precise crystal oscillators. In addition, Rakon envisions being environmentally friendly and sustainable and has reduced the carbon emissions per product. Endace specializes in FPGA-based high speed network monitoring and recording systems. Network monitoring and recording systems allow companies to accurately identify bottlenecks and performance impacting problems. Endace provides state-of-the-art data network solutions to various Telcos, broadcasters, governments and banks. Glidepath provides cost effective solution for baggage, cargo and parcel handling systems. Their advanced software control systems are designed to be integrated into existing information systems. Glidepath is a prominent world player in airport baggage handling systems and has provided solutions to over 60 countries world-wide.

While NZ has a lot of talent and potential in the ICT sector, the current export of advanced technology products is only at 10% [6] of the total GDP. The need to diversify NZ's economy to include high-value products based on ICT was recognized as early as 2001. The previous Vice Chancellor of Auckland University, Professor John Hood, along with the Prime Minster of the time, Rt. Hon. Helen Clarke (who is the current Administrator of United Nations Development Program), hosted a conference in 2001 especially focusing on this issue. This conference, called "Catching the Knowledge Wave", focussed on providing major impetus to diversify the NZ economy primarily based on knowledge: "education, innovation, research and development, enterprise, productivity, investment, training and expertise, migration and immigration, and others" [7]. Since then, successive governments have recognised the shortfall of technology exports and several incentives are in place for ICT companies to attract government funding as long as such funding can be utilized for enhancing their export potential. Callaghan Innovation is a government agency working in this direction. In 2013 eight different high-tech companies received grants specifically around the above concept of government support for export growth [8]. However, such funding is extremely competitive as the funding pool has very limited funds.

The success of a few NZ ICT companies illustrates the

Capital	Wellington
Largest city	Auckland
Language	English, Māori
Area Total	268,680 km^2
Population (2012 estimate)	4,464,000
Currency	New Zealand dollar ($) (NZD)
Time zone	**(UTC +12)**
Internet TLD	.nz

promising potential for New Zealand in the ICT sector. However, for further advancement, more support is needed from government agencies to especially foster industry-academia interaction. NZ has been a country of many innovations. One prominent example is the invention of Inductive Power Transfer (IPT) by Professor John Boys of Auckland University. IPT facilitates contactless power transfer and is now the default technology in many sectors such as material handling and clean rooms. While IPT was invented in NZ, it was initially commercialized through international partners such as Daifuku (Japan), as Professor Boys was unable to attract local funding to support this research. Only recently, a local NZ company called HaloIPT was set up for efficient charging of electric vehicles by the commercialization wing of the University of Auckland, called Auckland UniServices. Within a short span of 2-3 years, this company created many leading innovations in this sector and was acquired by Qualcomm in 2011. This example illustrates the need for further enhancement of the industry academia nexus through government support, especially for the ICT sector. Also, unlike large funding initiatives in USA, Europe and China to foster embedded systems research, there is hardly any government initiative in NZ that supports embedded systems. Contestable research funds such as Marsden Fund and Ministry of Science and Innovation (MBIE) grants are intensely competitive with success rates of around 10%. As a consequence, many bright ideas are unable to attract any funding. These grants either favour more fundamental research (as in the case of Marsden) or industry focused research (MBIE) with focus areas that are not related to embedded systems.

III. ACADEMIA

There are eight universities in New Zealand with University of Auckland (UA) being the country's largest tertiary institution. UA supports a wide range of faculties and disciplines: engineering, arts, science, law, education, medical health sciences, and business amongst others. The tertiary sector has collaboration with industry in a number of sectors to help commercialize research ideas. This is exemplified through pioneering technologies such as the world's first Twisted Flow Wind Tunnel for the America's Cup from the Faculty of Engineering and also the invention of IPT technology from the Department of Electrical & Computer Engineering of UA.

Although a relatively small country, OECD has ranked NZ's education system seventh best in the world. The tertiary education system has produced high-caliber graduates through a number of research-intensive universities, which are among the top portion in QS and Times Higher Education Rankings. For example, according to the Times Higher Education rankings, the University of Auckland is included in the top 200. Auckland's ranking of 161 is seventh highest of all Australian and New Zealand universities.

To ensure the next generation of New Zealand's engineers can meet the global challenges in the 21st century and beyond, considerable effort has been made by local universities to design new cross-disciplinary degrees. For instance, the University of Auckland offers degrees related to ICT such as Computer Systems Engineering, Software Engineering, Electrical and Electronic Engineering, Mechatronics Engineering and Bioengineering. Of these, the Computer Systems Engineering degree focuses on embedded systems and its curriculum is developed so as to provide the right balance between Computer Science related courses and Electrical Engineering related courses, as suggested by Sifakis and Henzinger [9]. University of Auckland also has strong research presence in the area of embedded systems with international collaborations with the French National Laboratory of Informatics and Control (INRIA), University of California Berkeley, Kiel University, and AIST (Japan). Embedded systems researchers have developed system-level languages and design methodologies such as SystemJ [10], IEC61499 Function Blocks [11, 12] and a family of processors for safety critical systems called reactive processors, which were proposed by UA researchers in 2002 [13]. NZ has all the key ingredients to become a world player in embedded systems. Some nurturing support from government agencies to foster industry-academia collaborations will propel embedded systems to the forefront of NZ's knowledge economy.

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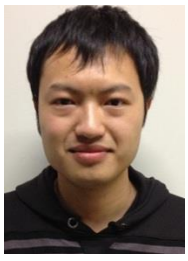

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