

Innovation Snapshot

Mobile technologies

Introduction

Mobile information and communication technologies encompass a wide range of products and services, including devices such as cellphones, smartphones, and tablets, and the software and infrastructure that supports and provides features for these. There are now over five billion mobile phone subscriptions worldwide, including over 24 million in Canada.¹

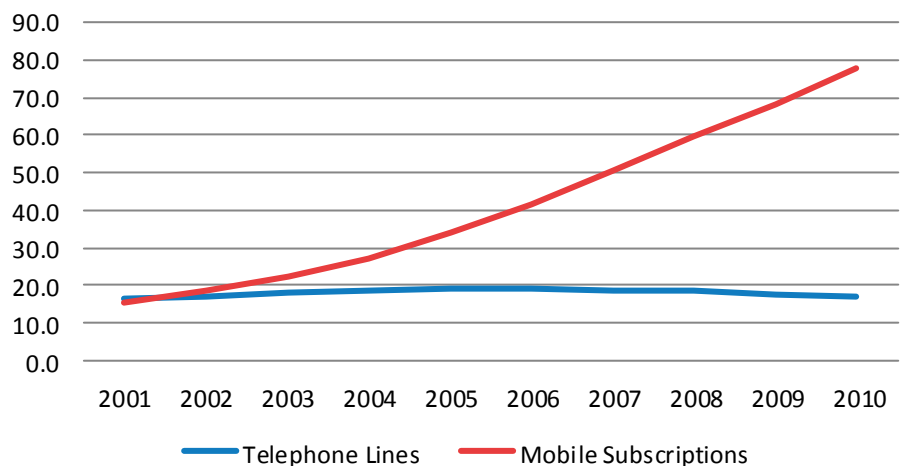
Mobile adoption has grown substantially across the world over the past decade and the market is expected to continue its rapid expansion. Since mobile infrastructure is cheaper than traditional landline infrastructure, emerging economies have been especially agile in adopting mobile phones. Meanwhile consumers and businesses demand an increasing amount of content through smartphones in developed parts of the world, requiring better and more advanced infrastructure.

Players in the industry include device manufacturers, such as Nokia, Samsung, Apple and Research In Motion; infrastructure providers, such as Ericsson, Alcatel-Lucent

and Nokia Siemens Networks; network carriers, such as AT&T, Vodafone, and SingTel; and content providers. With the rise of smartphones, content providers such as Google, who develops the Android operating system, and ‘app’ developers, are playing a larger role in the evolution of mobile solutions. Hundreds of organizations are competing to create products to serve growing consumer demand and to provide businesses with mobile solutions to exploit the productivity advantages of this expanding market.

Mobile devices, in particular smartphones, have helped transform the way in which content and services are delivered to consumers. ‘Apps’, designed to simplify and optimize the mobile experience, are the default way of interacting with these devices. There are now over 400,000 third-party applications for the Apple iPhone, and the app-centric model is used to deliver content to many different platforms, including Android and BlackBerry devices, and now even to laptops and desktops with the launch of the Mac App Store.

Figure 1: Telephone Lines and Mobile Subscriptions per capita in the world



Source: ITU

Did you know...

The United Arab Emirates has a mobile penetration rate of 233%, the highest in the world. This means that there are over two mobile subscriptions for every person in the country.

Mobile Industry in Canada

Despite wireless broadband coverage to 99% of its population, Canada has the lowest mobile adoption rate in the developed world. The lag in mobile adoption is likely the result of regulation in the Canadian wireless business market, which is mainly dominated by three large players, namely Rogers Wireless, Bell Wireless and Telus Mobility. However, the telecommunications market has recently seen increasing competition and growth with the entrance of new providers including Wind Mobile and Mobilicity (both headquartered in the Toronto Region). In addition, Canada has a smartphone adoption rate of around 36%, among the highest in the world.^{2,3}

Canada's revenues from wireless services are estimated to be over \$18 billion annually, the largest component (40%) of telecommunications revenue.¹

An upcoming spectrum auction in 2012 presents additional growth opportunities for telecommunication companies doing business in the country. The 700Mhz band to be auctioned offers wider coverage per antenna as well as better signal inside buildings.⁴

Companies

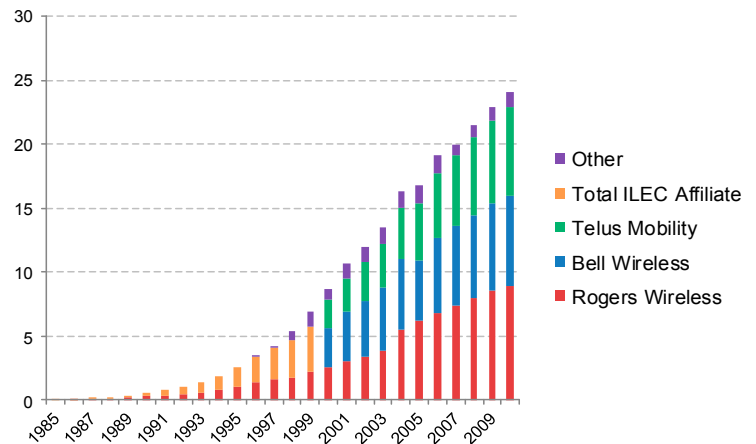
There are over 400 telecommunications companies, as well as many computer and software companies taking part in the Toronto Region's mobile environment. The region holds the largest concentration of telecommunications businesses in Canada, representing 24% of the country's total.

Global players in the mobile sector with offices in the region include Google, Cisco, Nokia Siemens Networks and Huawei.

The Toronto Region is also home to Research In Motion, one of the leading manufacturers of mobile devices in the world. In the last decade, their secure BlackBerry platform became the standard mobile technology in the business world. RIM saw its profits grow from \$85 million in 2000, to approximately \$15 billion in 2010, a clear picture of how the mobile market has emerged.

Low barriers to entry coupled with the region's entrepreneurial attitude have led to a spur of start-ups in the Toronto Region which develop mobile content and solutions. Companies able to stand-out by creating original products and adopting innovative business models are likely to see rewards from this growing and highly-competitive market. With an estimated 200 companies, Toronto has been named a 'hotbed' for mobile app development.⁵

Figure 2: Canadian Mobile Adoption by network carrier (Millions of mobile subscriptions)



Source: CWTA

Figure 3A: Regional Distribution of Telecommunications Businesses in Canada

1835 businesses in Canada

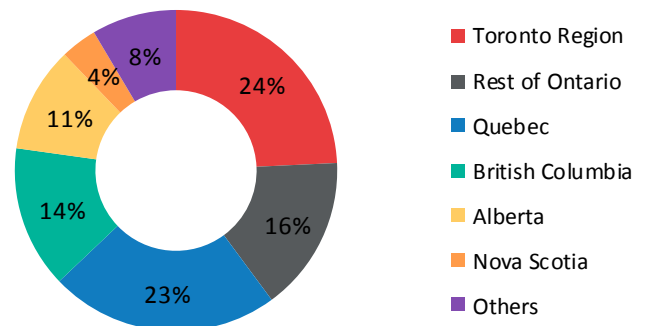
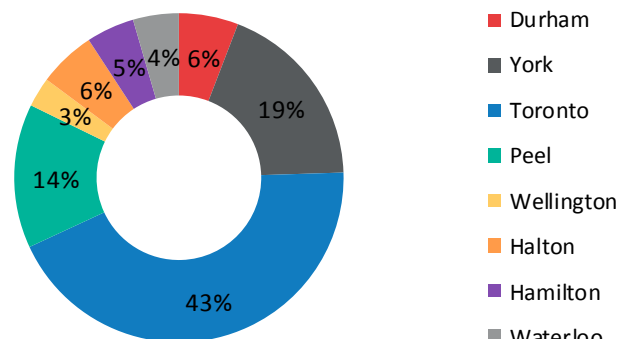


Figure 3B: Regional Distribution of Telecommunications Businesses in the Toronto Region

445 businesses in the Toronto Region



Source: Statistics Canada



Research In Motion (Waterloo) is the largest ICT company in Canada with approximately \$15 billion in revenue

(2010), 14,000 employees and an approximate 12% share of the smartphone market worldwide held by its BlackBerry platform. RIM's proximity to the University of Waterloo (UW), a top-rated Computer Science and Engineering school, has empowered the company with an uninterrupted stream of talent since its creation in 1984. RIM's culture of innovation has helped it become one of the mobile industry leaders. The BlackBerry smartphone is used by millions of people around the world, including U.S. president Barack Obama. Intensive research in cryptography and information security has allowed the company to maintain a strong presence at the enterprise level, where security is a key concern. Additionally, innovative features such as BBM messenger have made the platform popular among consumers.

Although it recently has lost some of its market share to Google's Android OS for mobile devices and Apple's iPhone, RIM is still a leader in the market being one of the top providers of smartphones in the world. Furthermore, RIM has entered the tablet market with its BlackBerry Playbook, competing against Apple's dominant iPad.



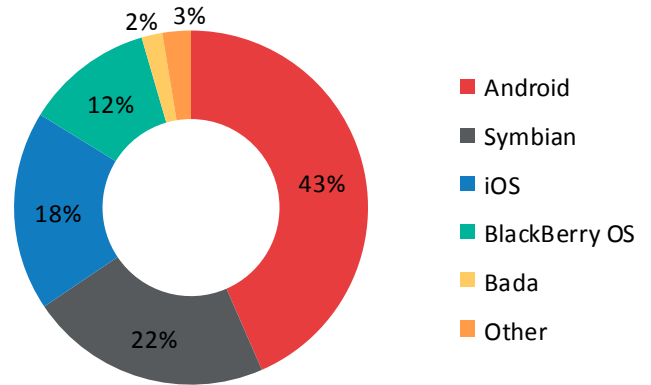
Polar Mobile (Toronto) has created a unique and proprietary platform which

allows media companies to efficiently deliver mobile apps. Through the 'SMART' solution, clients can efficiently reach consumers across different mobile platforms, including Apple's iOS, Android and BlackBerry OS. Polar serves magazines, newspapers, and online portals for sports and entertainment; customers include TIME, Bloomberg, CNN, and Sports Illustrated.

Polar has deployed over 500 mobile apps since its foundation in 2007. In addition, the company will extend its platform to support the Blackberry Playbook, planning to deliver over 100 apps for the device in 2011.

Other Toronto Region companies which develop mobile solutions include: Impact Mobile, Adenyo, Clip Mobile, Five Mobile (recently acquired by Zynga), Allegro Mobile Solutions, Seregon Solutions, Kik Interactive, myThum, Telepin, Redline Communications, XtremeLabs, and XMG Studio. In addition, four wireless telecommunications providers are headquartered in the region, including Rogers Wireless, the largest provider in the country.

Figure 4: Global Smartphone Sales by Operating System (2Q 2011)



Source: Gartner (August 2011)

Did you know...

BBM Messenger has over 43 million active users, 70% of them use it daily. Over 100 billion messages are sent each month through this exclusive BlackBerry service.



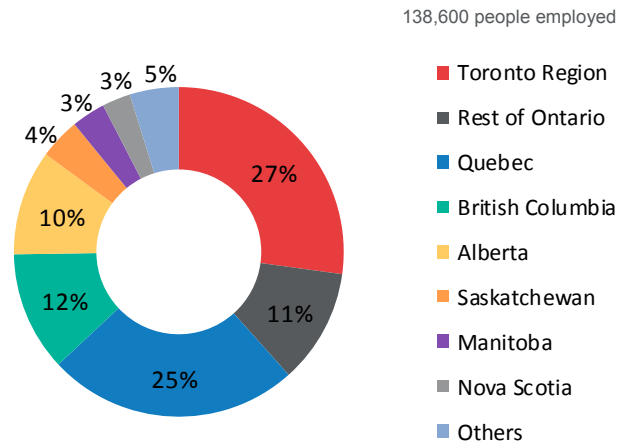
Wireless Telecommunications Providers headquartered in the Toronto Region

Talent and Labour Force

The Toronto Region possesses one of the most diverse and best educated new workforces in Canada. The region employs the largest number of people in the telecommunications industry in the country. Despite a highly educated workforce, the region's average salaries for information and communications technology (ICT) professionals are below that of comparable ICT clusters in North America.

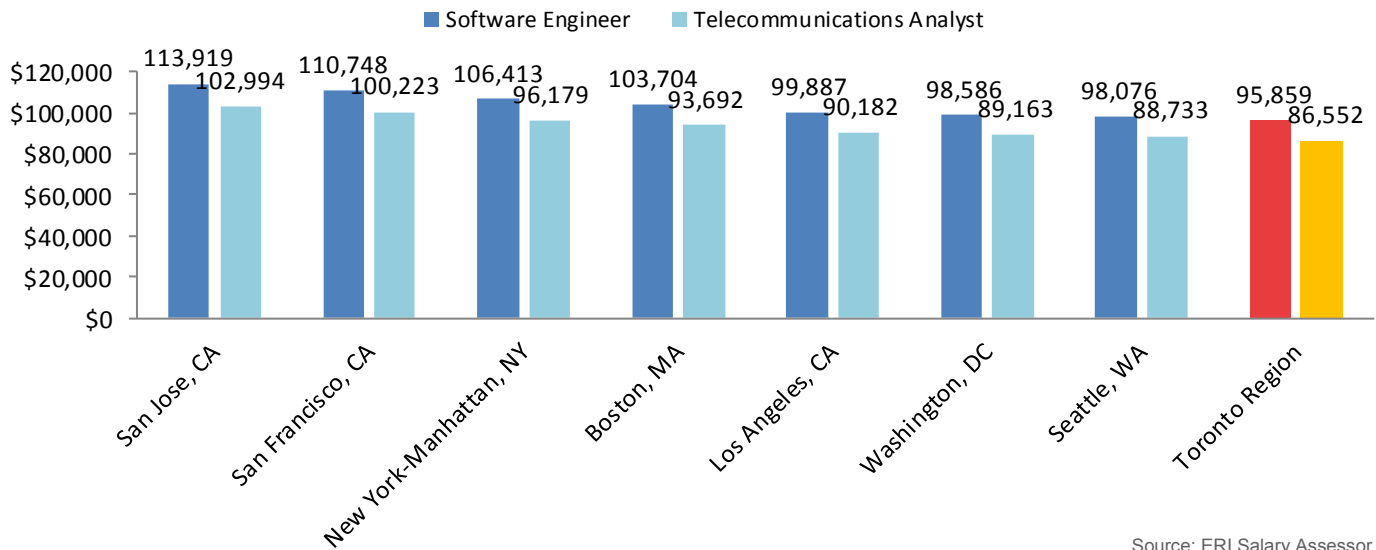
Located in the region are two of the best schools for engineering and ICT-related studies in the world, the University of Toronto (UofT), ranked 14th, and the University of Waterloo (UW), ranked 39th. They attract some of the brightest students from Canada and around the world.⁶

Figure 5: Regional Distribution of Telecommunications Labour Force in Canada



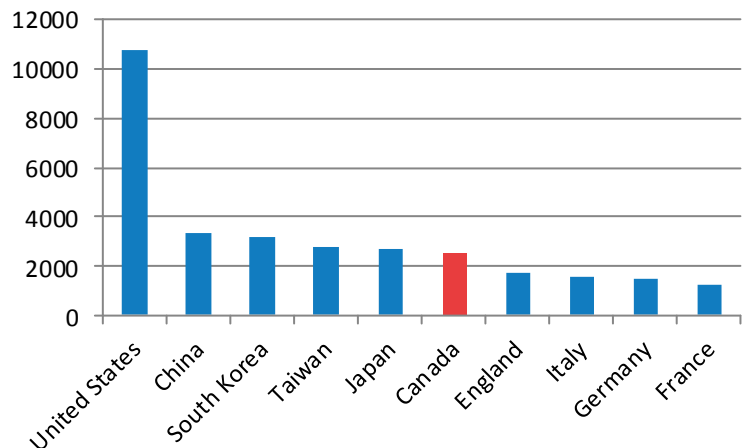
Source: Statistics Canada

Figure 6: Salary Comparison for North-American ICT Clusters



Source: ERI Salary Assessor

Figure 7: Top countries by number of mobile related publications (2001-2010)



Source: ISI Web of Knowledge

Publications

Canada and the Toronto Region are top publishers of mobile related material in the world. Canada is seventh in the world in number of publications. The Toronto Region is the top publishing region of mobile research in Canada. The University of Waterloo, with close ties to RIM and located only minutes away, has consistently placed among the top publishing institutions for wireless and mobile related publications over the past decade.

Patents

Canada ranks fifth in number of mobile related patents. The main regions in Canada for mobile patents are the Toronto Region, home to Research In Motion, and the Ottawa region, home to R&D centers for Alcatel-Lucent and Nortel in the past.

Globally, the Toronto Region is one the leading regions in number of mobile related patents—it ranks ninth in the world and it is first in Canada. Other top regions include Helsinki, home to Nokia, San Francisco and Tokyo.

The top assignee for mobile related patents in the Toronto Region is RIM. Other patent assignees with inventors in the region include Redknee Inc, Qualcomm, Motorola, IBM and Microsoft.

Did you know...

Sold in 1994, the IBM Simon is recognized as the world's first smartphone. It was priced at \$899 and included calendar, e-mail, and game applications. Similar to many modern devices, input was done through a touchscreen.⁷

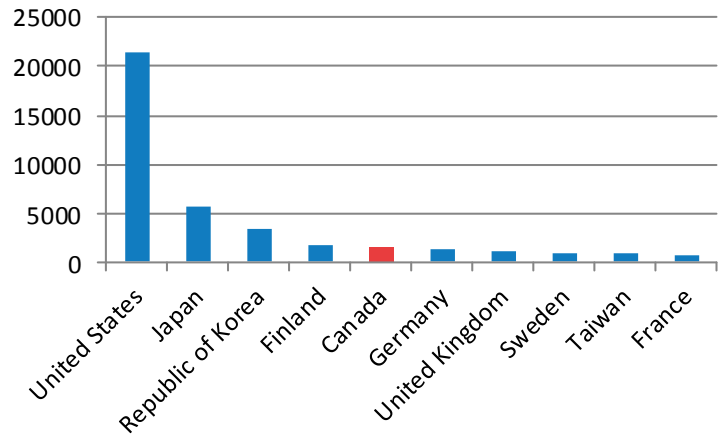
Funding

The Canadian government supports research in mobile and wireless technologies through the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Canada Foundation for Innovation (CFI).

From 2001 to 2010, funding totaled over \$170 million for more than 3,000 mobile related projects. Over 800 of these awards went to researchers at institutions in the Toronto Region, representing about a quarter of the total funding awarded. The University of Waterloo is the top recipient of funding in the country, researchers at UW were awarded over \$16 million for over 300 different projects.

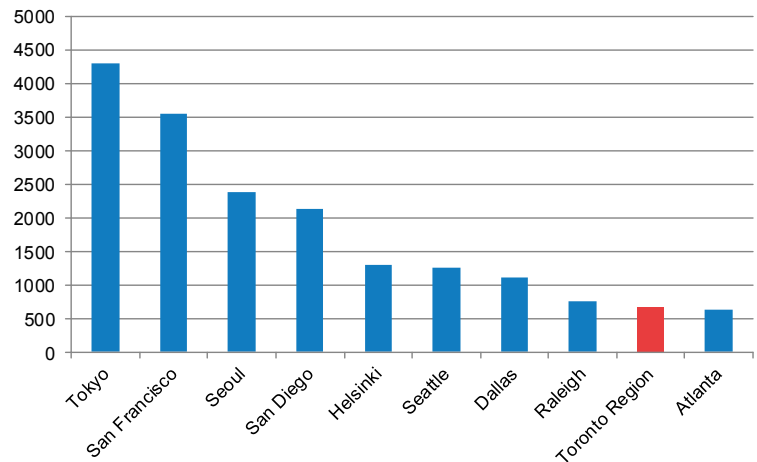
This funding provides support for the development of mobile technologies and applications. While some researchers in the region are working on making wireless networks and communications faster and more reliable, others focus on specific applications for these technologies in areas such as health and vehicular networks.

Figure 8: Top countries by number of mobile related patents (2001-2010)



Source: Thomson Reuters

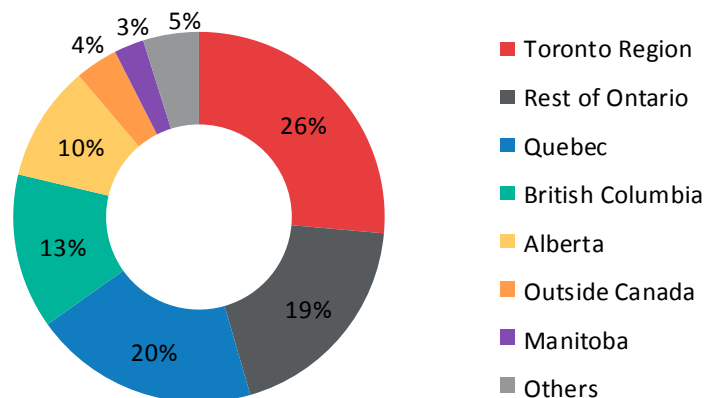
Figure 9: Top regions by number of mobile related patents (2001-2010)



Source: Thomson Reuters

Figure 10: Regional Distribution of projects funded by NSERC and CFI (2001-2010)

Total projects: 3,272



Source: TRRA Analysis based on NSERC and CFI

Research Institutes and Centres

There are 11 research institutes in the region which focus on research areas related or applicable to mobile technologies.

Radio Frequency technologies is an emerging area of research with a variety of applications. The **Centre for Integrated RF Engineering (CIRFE)** at the University of Waterloo specializes on these technologies which include RF Micro-Electro-Mechanical Systems (MEMS), miniature RFID, and wireless intelligent systems among others.

The **Emerging Communications Technology Institute (ECTI)** at the University of Toronto is an interdisciplinary institute which promotes collaborative research and provides access to state-of-the-art facilities for researchers working on areas such as device prototyping, wireless/mobility, network architecture, telecommunications and nanotechnology among others.



In addition to these research institutes, the **Mobile Experience Innovation Centre (MEIC)** located at the Ontario College for Art and Design (OCAD) University is an

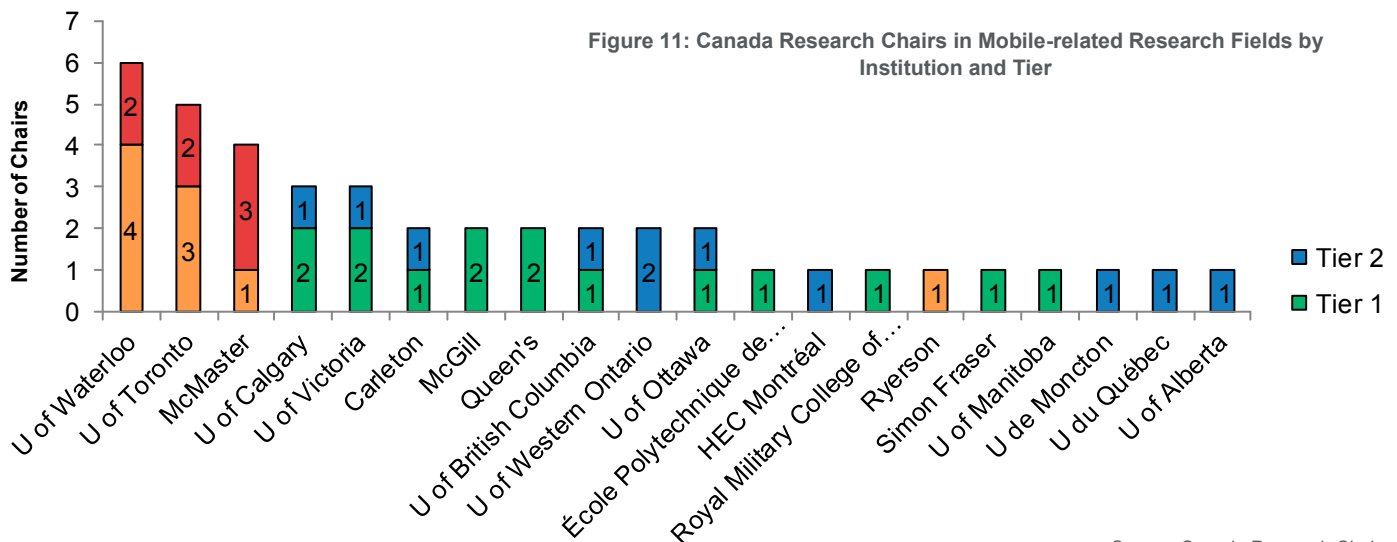
organization which focuses on Canadian design leadership, sector growth and integration, and innovation in all aspects of mobile technology. MEIC's efforts include supporting start-ups and SMEs, supporting research commercialization, and advocacy for Canadian companies in the national and international markets. MEIC receives funding from OCAD, the City of Toronto, and the Ontario Media Development Corporation (OMDC), and are involved with more than 150 businesses and institutions including RBC, RIM, Ryerson University, IBM, GestureTek, and CBC.

Experts

There are 42 Canada Research Chair experts in fields related to mobile technologies such as wireless communications, data delivery algorithms and networking architectures; 16 of these experts are located in the Toronto Region.

The University of Waterloo, The University of Toronto and McMaster University, all located in the Toronto Region, are the top three institutions in Canada for number of Research Chair holders in related fields.

Research Institutes
Centre for Emerging Device Technologies (CEDT)
The Privacy and Cyber Crime Institute
The Institute for Innovation and Technology Management (IITM)
Emerging Communications Technology Institute (ECTI)
Centre for Quantum Information and Quantum Control (CQIQC)
Centre for Integrated RF Engineering (CIRFE)
Institute for Quantum Computing (IQC)
Nortel Networks Institute for Advanced Information Technology (NNI)
Centre for Applied Cryptographic Research (CACR)
Waterloo Institute for Nanotechnology
Institute for Computer Research (ICR)



Source: Canada Research Chairs

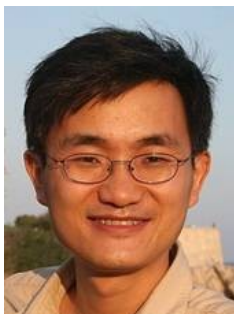
The following are selected Canada Research Chairs in the Toronto Region in areas related to mobile technologies.



Weihua Zhuang is a professor in the Department of Electrical Engineering at the University of Waterloo and Tier 1 Canada Research Chair in Wireless Communication Networks. She is an active member of the Broadband Communications Research Group and the Centre for Wireless Communications at UW and has been honored as a

Fellow and an Institute of Electrical and Electronic Engineers Fellow.

Dr. Zhuang has authored over one hundred papers on wireless communications and networking research, specializing in topics such as distributed resource allocation, mobility management, quality-of-service provisioning, congestion control, routing, and mobile user location in wireless networks among others. Recent projects include work in vehicular ad-hoc networking, which aims to enable and optimize wireless communication networks for automotive applications. In addition, she is a co-author of *Wireless Communications and Networking*, a textbook used by over 25 universities worldwide.



Wei Yu is an associate professor in the department of Electrical and Computer Engineering at the University of Toronto and a Tier 2 Canada Research Chair in Information Theory and Digital Communications.

Dr. Yu's research includes topics such as multiple antenna systems (MIMO), spectrum management, and broadband access networks such as 3G, 4G LTE and WiMax networks. Recent work includes a proposed system for mobile networks which improves network throughput and mitigates interference by coordinating resource allocation across base stations.

Tim Davidson is a professor of engineering at McMaster University and a Tier 2 Canada Research Chair in Communication Systems. He is also serving as Associate Director of the School of Computational Engineering and Science.



His research lies in the general areas of communications, signal processing, and control. More specifically, Dr. Davidson applies modern optimization theory to wireless communication systems. Recent work focuses on designing systems in which mobile devices and base stations are equipped with more than one antenna (MIMO) to improve data transfer rates.

Amir Khandani is a professor in the Department of Electrical and Computer Engineering at the University of Waterloo. He holds a Tier 1 Canada Research Chair on Wireless Systems and an NSERC- Nortel Network Industrial Research Chair on Advanced Telecommunications Technologies.



Dr. Khandani's research involves methods to increase efficiency of wireless networks and development of next-generation wireless system. He has authored or co-authored over 200 refereed articles and holds various related patents.

Conclusion

Mobile is a rapidly evolving industry in which innovation plays a pivotal role. The Toronto Region has very strong research assets in mobile technologies as revealed by its top global positions in publications and patents, and with the University of Waterloo and Research in Motion being recognized global leaders in the academic and industry fronts respectively. In addition, Toronto's diverse and entrepreneurial talent has led to a strong development ecosystem for mobile applications, making the region an exceptional location for mobile technologies R&D.

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