The Canadian Wireless Industry

Analysis, Positioning and Capabilities 2006-09

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TECHNOLOGIES
applied strategy | tactical planning

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Note to readers: This study was sanctioned in January of 2006, and majority of the market research and forecasts were conducted between January and March of 2006. These forecasts were based on data available from markets at the time. The majority of this data was accurate as of 2Q 2005 to December 2005.

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Executive Summary

Objectives

This study provides a detailed analysis of the Canadian Wireless Industry covering present and future capabilities and performance. The study positions multiple sub-sectors of the Canadian industry in relation to global trends and market dynamics.

The wireless technologies examined include: Cellular Equipment and Enablers; Devices including Cellular handsets, smart-phones and customer premise equipment (CPE); Mobile data; RFID; WiMAX; Wireless Fidelity (WiFi); Wireless Mesh; Ultra Wideband; and Software Defined Radio

The Wireless Ecosystem and Value Chain

The Wireless Ecosystem has evolved from a simple relationship between wireless operators, their networks and their customers, to a network of specialized companies contributing to a constantly changing value chain. One of the most influential changes to this ecosystem will be the gradual evolution towards Internet Protocol (IP)-based networks. The promise of IP Multimedia Subsystem (IMS)[1] is that multimedia services can be delivered across different access medium (fixed, mobile, broadband) and air interfaces. While operators have been trialing IMS globally, KAZAM expects the adoption of IMS to take place over several years. We already see pre-IMS services deployed in networks, with a gradual evolution to IMS compliance.

In addition to reducing the cost of network elements, IMS will provide greater flexibility for operators to offer multimedia, third generation (3G), and next generation services, more efficiently than before. The ability to integrate services, and to create and deliver multimedia rich, real-time applications rapidly, is a key driver for IMS. Additionally, Service Delivery Platforms (SDP) are being positioned to ideally support a complete ecosystem for the rapid deployment, provisioning, execution, management and billing of value-added services; aggregate different network capabilities and services; and content and data services in a way that is both network and device-independent. This creates greater efficiencies, greater economies of scale and greater opportunities for improved service creation and delivery.

[1] 3GPP, a global partnership of several standards bodies, developed the IP Multimedia Subsystem (IMS) specifications tailored for GSM/UMTS. 3GPP2 is working on a similar specification called multimedia domain (MMD) for CDMA2000 networks.

Wireless Industry Value Chain

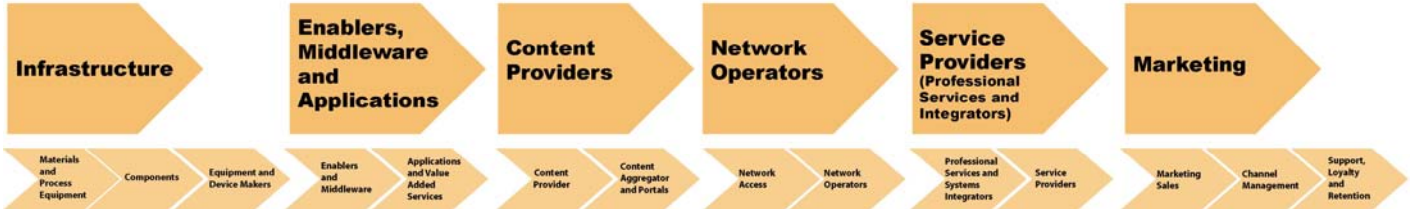

Figure 1 — KAZAM's Wireless Industry Value Chain

KAZAM's Wireless Industry Value Chain maps the wireless industry in stages, showing how each stage feeds and supports the next (see Figure 1). A weakness at any stage of the value chain can limit the potential and hold back the advancement of the entire value chain. Our study focuses on the components directly related to research and development (R&D) and innovation (Infrastructure; Enablers, Middleware and Applications; Content Providers), and the components directly related to providing services in the market (Network Operators; Service Providers).

Canada shows leadership and strength in infrastructure, data-centric devices, enablers, middleware and applications, either due to the number of active Canadian companies, or due to technological innovation with significant exports to international markets.

Canada has growing capability in content development and aggregation. According to industry participants, surveyed and interviewed as part of this study[2] Canada is just beginning to develop in the content and aggregation space, but is poised for high levels of growth due to the advanced talent and facilities available in Canada.

Canada faces challenges in effectively commercializing innovation and exporting it successfully to international markets. While there may be several reasons for this, the two main ones that were observed include: the limited resources of the vast majority of Canadian companies, which happen to be small and medium-sized enterprises (SMEs); and the general lag in the Canadian services market in introducing new technologies and value-added services. The largest single component of the value chain is represented by operators in terms of contribution to employment and revenues.[3] Canadian operators have historically taken a "smart follower" approach to the commercial deployment of technology. This, coupled with a lag in effective monetization, results in some local innovation companies seeking opportunities to

[2] KAZAM Technologies conducted a nationwide survey of Canadian wireless companies and interviewed several participating companies for the purposes of this study. Additionally, KAZAM also obtained input from international companies operating in Canada and outside of Canada.

[3] While the manufacturing industry generates more revenues and employs more people, this contribution is spread over multiple components of the value chain, i.e. infrastructure, enablers etc.

commercialize leading edge products in foreign markets. This presents several challenges for Canadian firms. The resources (people, time and investment) required to become established in international markets, coupled with the lack of international business experience, and often the lack of a local reference client, presents challenges. Partly as a result of this, while Canada is strong in R&D and innovation, it lags in commercialization and export of products.

The Canadian Wireless Industry

Manufacturing and Products Industry

The Canadian wireless equipment manufacturing and products industry is comprised of approximately 400 companies, mostly SMEs that employ about 21 000 people, and generate an estimated CAN$18B in revenues.[4]

Canada boasts one of the highest broadband penetration rates in the world and Canadian companies have learned to provide world-class services, despite the geographical challenges and the smaller population centres. The Government of Canada has encouraged this through policies to ensure equal access to all Canadians and through supporting R&D efforts to find new solutions and technologies.

The Canadian market's relatively small size (32.5 million people, approximately one tenth of the US), has not deterred companies in Canada from investing in innovation and R&D. The total domestic expenditure on R&D in Canada was over CAN$26B in 2005, representing a 7.4 percent CAGR between1996–2005.[5]

Stemming from this, Canadian companies have developed solutions that are smart, forward-thinking and innovative. By addressing its own challenges, including a large geographically dispersed nation, with evolving processes, new technologies, and new business models, Canada is poised to provide profitable and innovative solutions to the markets in the world that face similar geographic challenges, and competitive markets with limited spending power.

[4] KAZAM estimates are based on information collected from multiple industry sources, public information, the Branham 300 rankings, the CWTA, and Regional Clusters including WINBC, WiTec, Communitech, Toronto Wireless Developer User Group (TorWUG), OWC, OCRI, IIT, etc. This list also includes companies that manufacture components, semiconductors, infrastructure and devices for the wireless industry; provide enabler and middleware products and solutions; develop and aggregate mobile content; and companies that develop mobile applications and solutions. This also includes international companies with presence in Canada. For international companies with operations in Canada, only the revenues generated from and the employee base in Canada was taken into account. The estimates take into account all of the revenues and employees, irrespective of the percentage of resources dedicated solely towards wireless.

[5] Source: Statistics Canada, *Domestic spending on research and development (GERD)*, 2005 http://www40.statcan.ca/l01/cst01/scte03.htm.

Canada has one of the most culturally diverse and highly educated workforce in the world, and some of the most advanced educational institutions. Canadian companies also have easy access to capital. This, coupled with one of the most generous R&D tax credit systems in the world, has attracted the R&D facilities of many foreign multi-nationals including Ericsson, Motorola, Nokia, and Siemens.

Canadian companies exhibit strength in the manufacturing of high-quality products, and in high levels of customer care and post sales support.

The study positions the Canadian wireless ecosystem in four categories:

- **Areas of Leadership**
    - Cellular Equipment (core and access technologies)
    - Data-centric mobile devices and CPE
    - WiMAX Equipment
    - Software Defined Radio (SDR) solutions and architecture
- **Areas of Strength**
    - Innovation and Entrepreneurship of small innovation companies
    - Internet Protocol (IP) infrastructure for next generation networks (IMS/MMD) and Mobile Service Enablers (Short Message Service Centre [SMSC], Multimedia Messaging System Centre [MMSC], Media Gateways etc.)
    - Wireless Fidelity (WiFi) mesh network equipment and associated services
    - Semiconductors for base station equipment, CPE, handsets
    - Professional Services, Business process improvement, product and service development
- **Areas of Development**
    - Mobile content and aggregation
    - Radio Frequency Identification (RFID), tags and readers, integration services
    - Cellular services
- **Area of Challenge**
    - Cellular Handset Development
    - WiFi Access Points (AP) and CPE
    - Ultra Wideband (UWB), devices

The Canadian Cellular Services Industry

The Canadian cellular services industry is comprised of approximately 15 national, regional and municipal cellular operators. These operators employ approximately 16 000 individuals[6] and generate more than CAN$10B in revenues annually, which represents almost 30 percent of the Canadian telecommunications market.[7] According to IDC, the Canadian wireless industry has been experiencing an annual growth rate three times that of any other Canadian telecommunications sector. This is significant for a country that is in the top 10 percent of the world for broadband Internet penetration[8] and amongst the world's leading countries for tele-density. The Canadian wireless telecommunications market is expected to generate over CAN$15B by 2009, representing an 11.5 percent compound five year growth from 2005 to 2009[9]. While this represents about 8 percent of the US market, which currently stands at over US$122B, the Canadian wireless market is growing at a faster pace than its US counter-part.

Canadian operators were quick to collaborate on Short Message Service (SMS), short codes and Multimedia Messaging System (MMS), and were first in North America to ensure inter-carrier inter-working. Canadian operators have also recently undertaken an initiative to jointly support mobile-commerce (m-commerce). Canadian operators exhibit some of the most impressive performance indicators among North American operators. Canadian operators rank 1st and 2nd for lowest churn, 3rd and 6th for lowest cost of acquisition, and in the top eight for subscriber growth in North America.[10] Due to their smaller size relative to global operators, Canadian operators have taken a "smart follower" approach when it comes to the commercial deployment of new technologies and services. While a smart follower approach makes good business sense for an operator, a consistent lag in the commercial deployment of new technologies and, more importantly, slow monetization of the technology investment,[11] impacts the entire value chain. As a result, Canadian vendors with leading-edge technologies ahead of the local needs must seek out international markets to commercialize their products in order to remain competitive. It is hoped that the growing level of new competition, as a result of disruptive technologies and new entrants, will create more incentive, stimulus and support for

[6] Source: CWTA, *Direct Employment of Cellular/PCS Providers in Canada*:, http://www.cwta.ca/CWTASite/english/facts_figures_charts/employ_e.html.

[7] Source: IDC, *Wireless Wars 2: Canadian Wireless Forecast and Analysis, 2005-2009*, http://www.idc.com/getdoc.jsp?containerId=CA1712TMS.

[8] Source: Internet World Stats, *World Internet Usage Statistics*, December 31, 2005.

[9] Source: IDC, *Wireless Wars 2: Canadian Wireless Forecast and Analysis, 2005-2009*, http://www.idc.com/getdoc.jsp?containerId=CA1712TMS.

[10] Source: N. Moore Capital Limited NY 2004.

[11] Although Canada was the first in North America to support inter-carrier inter-working for SMS, MMS and short codes, Canada has been relatively slow to monetize this leadership through enhanced value-added services, as an example, the use of premium SMS is just starting to pick up.

the active and timely local commercialization of products and more effective monetization of the investment.

Regional Clusters and Associations

The Canadian regional clusters and wireless associations bring together different players within the industry to: advocate change, provide a collective forum and voice, and fulfill the need for industry education (i.e. cellular safety). The potential role of clusters and associations is as a portal to the industry, for both industry members and outside parties, facilitating visionary planning and cooperation among regional associations and clusters across the country.

Summary

Canada is a hotbed for innovation in wireless. A substantial number of Canadian companies are either leaders or show significant strength at various levels of the value chain. This stems from an entrepreneurial environment that is ranked in the top 10 for entrepreneurial access to capital,[12] ranked second amongst the Organization for Economic Co-operation and Development (OECD) countries[13] in tax relief per R&D dollars spent, and has a diverse and highly skilled workforce, which is ranked into the top 10 worldwide.[14] A large majority of Canadian companies in the wireless ecosystem are SMEs.

In addition, regionally centered wireless clusters made up of highly innovative and competitive companies, government facilities and incentives to support leading edge R&D, and easy access to the large US market, have contributed to the presence of multi-national R&D centres in Canada. These include Ericsson's Canadian Centre of Excellence (the largest outside Sweden), and Siemens AG's Technology Innovation Centre, a proof of the conducive innovation environment of Canada.

As a result, Canada offers a fertile environment for foreign companies wishing to establish technology and channel marketing partnerships.

Wireless Sector Trends and Growth

Cellular Infrastructure sales are expected to grow at 2.8 percent CAGR,[15] approaching US$50B worldwide by 2008. The majority of the spending will come

[12] Source: Milken Institute, *2005 Capital Access Index*, http://www.milkeninstitute.org/pdf/ca_2005.pdf.

[13] Ranked second in tax relief per R&D dollar spent among OECD countries, Source: Institute of Competitiveness and Prosperity based on OECD economic surveys Canada– Volume 2003/14 September.

[14] Ranked ninth in the world on the Human Capital Index, Source: UNCTAD, Human Capital Index 2001.

[15] Source: IDC Worldwide Wireless and Mobile Network Infrastructure 2004 – 2008 Forecast and Analysis, December 2004. Note that these forecasts exclude PDC/TDMA/iDEN/TD-SCDMA technologies.

from Western Europe (27 percent) and Asia Pacific (33 percent). Spending in developed and mature markets of North America, Western Europe and parts of Asia Pacific will come from the evolution to 3G to support enhanced mobile data services, content and applications. Emerging markets, including Brazil, Russia, India and China (BRIC) countries, Middle East and African (MEA) countries, Asia, and Latin America will represent the majority of the worldwide subscriber growth, with BRIC countries representing over 50 percent of the world's subscriber growth between 2006 and 2009.[16] Canadian companies hold the number two position in Code Division Multiple Access (CDMA) infrastructure sales[17] and number three in Gigabit Ethernet switching equipment.[18]

Cellular Device sales are expected to grow at 2 percent CAGR, exceeding US$135B worldwide by 2009.[19] In data-centric mobile devices, Canadian companies have shown global leadership through unique and innovative end-to-end solutions for email and data communications. For instance, Research in Motion (RIM) has attained the largest market share of the worldwide PDA market in 2005, based on worldwide shipments.[20] Sales of high tier replacement handsets and smart-phones will grow in developed and mature markets. Handset vendors will have to meet the growing demand for ultra low cost handsets from emerging markets.

Mobile Data spending is expected to grow at 20 percent CAGR, exceeding US$193B worldwide by 2009.[21] The majority of the spending will come from the mature markets of Asia Pacific (44 percent) and Europe (30 percent).[21]

Worldwide Interoperability for Microwave Access (WiMAX) spending is expected to grow at 98 percent, exceeding US$3B worldwide by 2009.[22] Adoption of WiMAX will grow as cheaper CPE's become available, and as laptops with embedded WiMAX modems become pervasive, over the next several years.

Wireless (WiFi) Mesh spending is expected to grow at 96 percent, exceeding US$976M worldwide by 2009.[23] The majority of the spending will come from Europe

[16] KAZAM estimate.

[17] Source: Dell'Oro Group: Mobility Infrastructure Market Revenues Climb 29% in 2004, February 2005, http://www.delloro.com/news/2005/Mob021605.htm.

[18] Source: Dell'Oro Group: High-End Ethernet Switch Market Grows 12% in Q4/04 (2005) http://www.delloro.com/news/2005/ES021705.htm.

[19] KAZAM Mobile Handset Forecasts, 2006.

[20] Please note the numbers are preliminary. Source: Gartner, *Gartner Says Worldwide PDA Shipments Reach Record Level In 2005*, February 14, 2006 http://www.gartner.com/press_releases/asset_145348_11.html.

[21] KAZAM Mobile Data Forecasts, 2006.

[22] KAZAM WiMAX Forecasts, 2006.

[23] Source: In-Stat Market Alert: *Wireless Mesh Network Equipment Market Accelerates*, October 2005 http://www.instat.com/newmk.asp?ID=1462.

(30 percent) and Asia Pacific (36 percent).[24] With the pervasiveness of WiFi CPE's, municipalities, universities and other non-traditional entrants will look to wireless mesh to offer wireless broadband connectivity.

WiFi (wireless LAN) spending is expected to grow at 20 percent, exceeding US$6.1B worldwide by 2009.[25] The majority of the spending will come from North America (23 percent), Europe (23 percent) and Asia Pacific (50 percent).[25]

RFID tags and reader spending is expected to grow at 17 percent, exceeding US$3.7B worldwide by 2009.[26] The majority of the spending will come from North America (43 percent), Europe (31 percent) and Asia Pacific (21 percent).[27] The pharmaceutical, logistics, and retail verticals will be spending the most on RFID deployments in North America. Due to RFID requiring extensive integration services, it is expected that integration service spending will surpass RFID hardware spending by year-end 2007.[28]

Opportunities

Opportunities in developed and mature markets: North America and Western Europe offer Canadian firms opportunities for providing infrastructure to evolve cellular networks to 3G; for enablers to create and deliver value-add data and multimedia services; and for products that facilitate evolution to IP multimedia core (IMS/MMD). Growth in applications and content will provide Canadian companies with opportunities in these markets. WiMAX, wireless mesh, software defined radio, and professional services also present opportunities for Canadian firms. Opportunities for Canadian companies in Japan and South Korea are somewhat limited, as these markets are highly mature, and therefore develop indigenous, pre-standards products. Some opportunities exist in these markets for business and enterprise solutions (i.e. Customer Relationship Management [CRM], ERP, etc.) and professional services.

Opportunities in emerging markets: The BRIC countries, and the emerging markets within Latin America, MEA, and Asia Pacific offer opportunities as a result of growth in subscribers and network footprint. Several emerging countries including Argentina, Nigeria, Pakistan, Bangladesh, Turkey and Serbia also present good opportunities, with some offering lower barriers to entry than the much larger BRIC countries. Low average revenue per user (ARPUs)[29] in several emerging markets result in downward pressure for

[24] KAZAM Wireless Mesh Forecasts, 2006.

[25] KAZAM WiFi Forecasts, 2006.

[26] Source: Lehman Brothers, RFID Today, March 2005.

[27] KAZAM RFID Forecasts 2006.

[28] Source: Lehman Brothers, RFID Today, March 2005.

[29] ARPU between US$5 and US$12 for China and US$10 for India Source: Operator reports.

infrastructure spending. This has been a catalyst for the success of vendors providing low cost equipment from emerging markets such as China (ZTE, Huawei, etc). As only one fourth of India's population base is covered by cellular, opportunities to sell infrastructure to India do exist. However, low cost solutions are needed for emerging markets. Spending in WiMAX, wireless mesh, and handsets will also grow in these regions. Opportunities for UWB, and SDR are limited at this time.

Conclusions and Next Steps

Canada, as a platform for the development of groundbreaking innovation, as an ecosystem of cooperative and interconnected firms and as a gateway to the US market, is a powerful launching pad for local companies developing new solutions, and for international wireless companies looking to establish partnerships and develop opportunities.

Canada's strength in technology training and research, coupled with one of the most generous R&D tax credit systems in the world, makes Canada a good location for leading edge R&D, and it has attracted the R&D facilities of many foreign multinationals.

Canadian based companies have opportunities in North America, Western Europe and the mature markets of Asia-Pacific for advanced 3G infrastructure, enablers, applications and content, particularly in the US. Emerging markets of Latin America, Middle East and Africa (MEA), and Asia Pacific, present Canadian companies another opportunity, due to high subscriber growth. The strongest opportunity markets for RFID equipment and associated services are Western Europe and the US. The Asia Pacific region represents the greatest opportunity for WiMAX equipment. Wireless Mesh is expected to grow, particularly in Western Europe and North America, creating opportunities for Canadian companies with municipalities, utelcos and other non-traditional operators.

While Canada has clear leadership and strength in supporting R&D excellence, the small size of the local market, the large percentage of SMEs with limited resources, coupled with the relative lag in the introduction of new technologies for mass consumption, and the slowness in monetizing the technology investment, has contributed to the slowing down of the commercialization and export of products. The small size of Canadian SMEs limits their ability to tap into large and emerging markets beyond the US (i.e. BRIC countries), which require local presence, have long sales cycles, and will sometimes have political, technical and business preferences that create barriers to entry.

The overall responsibility for rapid monetization of technology investment through value-added services is a shared responsibility and does not lie solely in the hands of the operators. For instance, in the case of mobile data services, content and applications, operators, content developers and providers, as well as regulatory policy all play a role. However, given the infrastructure investment being made in evolving to 3G and to support high-speed data services, timely and effective monetization of this investment is in the best interest of operators. While Canadian consumers are not identical to those in

Japan and South Korea, there are similarities. Canadian operators, content providers, and our regulatory environment can benefit from the experiences in mature markets for the successful deployment of value-add services, especially mobile content.

The next step is to develop mechanisms to foster greater support for Canadian companies commercializing products in the local market. This will enable these companies to export products internationally with essential local reference clients. Additionally, programs that guide Canadian SMEs in understanding, entering, and exporting products to emerging markets, need to be considered.

Chapter

2

Methodology

This study is based on first-hand insights gained through years of extensive work by KAZAM's experts in Canadian and other global markets; primary and secondary market research; as well as discussions with industry trade associations, vendors and operators. Information was extracted from KAZAM's in-house data sources, knowledge base, and insights from staff as well as through partners and clients. The secondary market research consisted of, but was not limited to, analyzing published sources of information including market studies from various research houses such as ABI Research, IDC, Gartner, Ovum, the Yankee Group, etc., as well as industry periodicals, conferences, vendor reports, and publicly available documents. A key piece in collecting and verifying data was a series of discussions, interviews, and correspondence with key industry players in Canada and abroad.

Worldwide cellular subscriber numbers and penetration rates were projected by KAZAM, based on source data obtained from the International Telecommunication Union,[30] the CDMA Development Group (CDG),[31] the GSM Association (GSMA),[32] regional telecommunications associations including the Canadian Wireless Telecommunications Association (CWTA), Cellular Telecommunications Industry Association (CTIA) — The Wireless Association, and 3G Americas. Worldwide population estimates were obtained from the US Census Bureau[33] and CIA World Fact Book.[34] Other sources of information included operator reports, industry presentations, vendor reports, and public sources of information. Mobile data estimates were obtained from sources including KAZAM internal resources and information, OECD studies,[35] operator and vendor reports, industry presentations, and public sources of information. Cellular infrastructure estimates were obtained from an IDC report [36]and cellular infrastructure technologies before 2.5G and nascent technologies such as Time Division Synchronous CDMA (TD-SCDMA) were left out of the market projections. For areas where overall wireless industry projections were made to 2009, infrastructure numbers were projected out to 2009 based on trends from 2006 to 2008. A key assumption made here was that infrastructure spending trends would continue for each region with no major changes expected between 2008 and 2009 for each region. Unless otherwise stated, all monetary amounts are in US dollars. Mobile handset estimates were obtained from internal sources and external market alerts, with KAZAM projecting that the average handset prices will drop from $140 to $127 as sub $50/$30 handsets appear in the market and drive handset sales in developing regions. Sales of replacement handsets will form the majority of handset sales in developed and mature markets, which will be higher in price, thereby offsetting the effects of sub $50/$30 handset sales in emerging markets.

[30] Source: International Telecommunication Union website, http://www.itu.int/ITU-D/ict/statistics/at_glance/cellular04.pdf.

[31] Source: CDMA Development Group website, http://www.cdg.org/.

[32] Source: GSM Association website, http://www.gsmworld.com/index.shtml.

[33] Source: US Census Bureau website, http://www.census.gov/ipc/www/idbsprd.html.

[34] Source: CIA World Fact Book https://www.cia.gov/cia/publications/factbook/index.html.

[35] Source: OECD, *Digital Broadband Content: Mobile Content (New Content for New Platforms)* May 2005, http://www.oecd.org/dataoecd/19/7/34884388.pdf

[36] Source: IDC, *Worldwide Wireless and Mobile Network Infrastructure 2004 – 2008 Forecast and Analysis*, December 2004.

WiMAX and Wireless Mesh Revenues were obtained from public sources including market alerts from key research houses[37] and merged with internal projections for regional growth. WLAN figures were obtained from public sources and market alerts[38] and projections were based on estimated hotspot growth and WiFi chipset sales to the different regions worldwide. RFID revenues are for both tags and readers and are based on forecasts from Lehman Brothers and ABI Research. Regional revenues were estimated by taking into account the fact that the US market will account for nearly 50 percent of the RFID market driven by the US Department of Defense (DoD) and the EPC Global Consortium (EPC) formed by retailing and pharmaceutical giants. The European RFID market will be half the size of the US market but will gain market share as will the Asia Pacific market. The Latin American and MEA markets will remain relatively small with regards to the global RFID market.

While reviewing several market studies from distinguished research houses, KAZAM at times found variance in market projections. For instance, Figure 2 illustrates the differences between wideband Code Division Multiple Access (WCDMA), Universal Mobile Telecommunication System (UMTS) Handset Shipments from various research houses aggregated by QUALCOMM. In these instances, KAZAM vetted the data using first-hand knowledge where applicable and interviews with industry players to suggest our view. Our view takes into account how nascent the technology is, status of standards, certification, interoperability and commercial production plans of vendors. These are particularly important when considering WiMAX, which has considerable initial market hype, and UWB, which has been plagued by competing proposals for standardization. In the case of 3G handsets, KAZAM's estimates for 3G handset shipments for 2007 fall in the 60 – 80 million units range (conservative to aggressive).

Regional cellular penetration rates have been derived via a weighted average. As cellular penetration rates are determined by dividing total cellular subscribers by the total population of a given country. For example, for the North America regional cellular penetration rate the formula used was: [(Canadian Cellular Subscribers/North America Cellular Subscribers)*Canadian Cellular penetration rate + (US Cellular Subscribers/North American Cellular Subscribers)*US cellular penetration rate].

[37] In-Stat Market Alert: *Wireless Mesh Network Equipment Market Accelerates*, October 2005 http://www.instat.com/newmk.asp?ID=1462. *WiMAX – Ready for deployment?* September 2005 http://www.idate.fr/pages/index.php?rubrique=etude&idr=16&idp=104&idl=7.

[38] WiFi Planet, *Look Back to Look Ahead at WLAN Sales*, February 2005. http://www.wi-fiplanet.com/news/article.php/3485791. In-Stat Networking Quarterlies—WLAN http://www.instat.com/catalog/ncatalogue.asp?id=160#IN0501943WL.

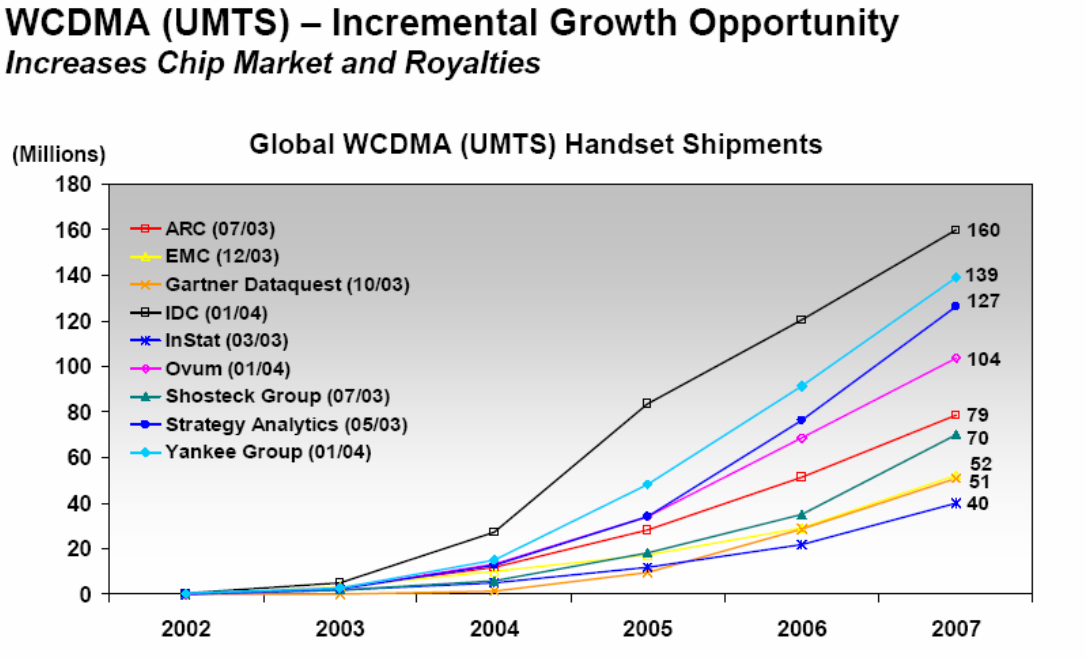

Figure 2 — Worldwide WCDMA (UMTS) Chipset Market[39]

KAZAM's estimates for the Canadian Wireless Industry include companies that are involved in or support the wireless ecosystem. The Cellular Service Provider sector is comprised of all national and regional cellular operators across Canada. The wireless products companies in Canada are comprised of wireless component and semiconductor manufacturers, equipment manufacturers including infrastructure and devices, enabler and middleware equipment and solution providers, mobile content developers and aggregators and mobile application solution providers. Professional services companies and cellular operators are excluded from these projections. For those companies in the wireless products industry that do not have a 100 percent focus on wireless, we estimate that approximately half of the staff is dedicated to wireless. KAZAM's estimates also include international companies in wireless with operations in Canada. Revenue numbers for these companies only include revenues generated from Canadian operations. Revenue numbers are in US dollars.

Given that it was extremely challenging to obtain accurate and recent information on the Canadian Wireless Industry, KAZAM leveraged information from Statistics Canada, Industry Canada, national wireless associations as well as regional clusters. Based on the information obtained, our estimates are not exhaustive and are subject to change

For this study, the six key regions worldwide are broken down as follows:

[39] QUALCOMM, *3G CDMA Enabling Mobile Wireless Data*, April 2004 http://www.fcc.gov/oet/tac/Qualcomm_ContributionEVDO_WCDMA_TAC.pdf.

- **North America:** Canada and the United States.
- **Latin America:** Mexico, South America and the Caribbean.
- **Western Europe:** United Kingdom, Ireland, Iceland, Norway, Sweden, Finland, Denmark, Netherlands, Greece, Germany, Luxembourg, Belgium, France, Switzerland, Liechtenstein, Austria, Italy, Spain, Portugal, Malta and Monaco.
- **Eastern Europe:** Belarus, Bulgaria, Czech Republic, Hungary, Poland, Republic of Moldova, Romania, Russia, Slovakia, Ukraine, Azerbaijan, Estonia, Georgia, Latvia, Lithuania, Albania, Turkey, Bosnia and Herzegovina, Macedonia, Serbia and Montenegro, Croatia and Slovenia. The Baltic States are 3 Eastern European countries namely Estonia, Latvia and Lithuania.
- **Middle East and Africa:** All of Africa and Armenia, Bahrain, Georgia, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkmenistan, UAE and Yemen.
- **Asia Pacific:** Includes all countries in South and South-east Asia, and the Pacific Rim (Afghanistan, Bangladesh, India, Pakistan, Sri Lanka, China, Japan, Korea, Taiwan etc.), as well as Australia, New Zealand and the surrounding areas.

SWOT Methodology

The methodology to determine the strengths, weaknesses, threats, opportunities and relative positioning of the Canadian wireless industry is two-fold. We have examined the Canadian Wireless sector using both a qualitative and quantitative methodology to compare the Canadian Wireless Ecosystem Value Chain performance for weaknesses and strengths, using South Korea and US as benchmarks.

The qualitative component of the analysis draws on interviews with key industry players, insight and experience from consulting within the international wireless space and conclusions drawn from the trade press, recent studies and anecdotal information.

The purpose of the quantitative component of the study is to compile a large number of diverse measures into a clear array of subsets and easily comparable scores. The quantitative component of the study will draw on multiple internationally recognized sources of data to measure market factors (industry specific indicators) and non-market factors (country/regional indicators). The criteria that are used to measure each region and country are selected to offer variance in viewpoint and perspective.

Grouping

The criteria are grouped under each sub-category (i.e. community, position of the community) then each sub-category is grouped under the corresponding main category (i.e. Market, Non-Market).

Scoring

Each criterion is then scored, consisting of entering the raw data for each criteria then indexing the raw data to the average of all of the scores. The score that is then entered into the analysis is a score (i.e. 54 percent, 150 percent etc) that is a ratio of the country or regional measure to the average of the raw measures. As examples, a score of 100 percent is average, a score of 50 percent is half of average and score of 200 percent is twice the average.

The following are the categories and criteria considered in our comparison:

Market Criteria

Community

- Number of companies in sector
- Number of engineers per 1000 inhabitants
- Number of employees employed in sector
- Percent of world players active in market
- Percent of world players based in market
- Revenue generated by sector companies
- Market capitalization
- Percent of companies in sector publicly traded

Position of Community

- Share of Worldwide Market Share held by home companies
- Percent of world market share in home market
- Percent share of home market
- Growth potential of technologies originating in country
- Strength of dependent value chain links
- Number of technologies being implemented in country
- Number of technologies being developed in country

Investment and Commercialization activity in sector

- Investment in telecom infrastructure with private participation
- Broadband equipment spending
- Equipment sold to consumers
- Equipment sold to enterprises
- Hardware, software, services and equipment sold to NSP's in region
- Total wireless data spending/subscriber
- Total Wireless voice spending /subscriber

Non-Market Criteria

Research and Development

- R&D spending as percentage of GDP
- Patents and trademarks royalties received
- Patents and trademarks royalties paid
- Scientific and technical journal articles
- High tech exports
- High tech exports as percent of manufactured exports
- Patents and Trademark applications filed locally by residents

International Investment/IP Protection

- Membership in WTO/TRIPS
- Membership in WIPO
- Membership in EU or other trade agreements
- Capital Access Index
- Inward FDI Performance Index
- Inward FDI Potential Index

Access to Skilled Resources

- Human Capital Index
- Governmental Rating Autocratic vs Democratic
- Human Development Index
- Human Security Index
- Impact of corruption on personal life
- Belief situation in region is not changing or getting worse
- Researchers employed in R&D
- Technicians employed in R&D
- Personal computers
- Public expenditure on education
- Number of students enrolled in tertiary level technical subjects
- Technological Activity Index

Governance Strategic/Management

- Governance
- Growth Competitive Index
- Macroeconomic Environment
- TI Corruption Perceptions Index 2004
- Government Effectiveness
- Regulation Quality
- Rule of Law
- Control of Corruption
- Voice and Accountability
- Political Stability

Business/Political Corruption

- Perception of absence in business environment
- Perception of absence in political environment
- Political parties/parliament/legal/business/tax/registry
- Grand/political and petty administrative corruption

Contract Law and Disclosure

- Enforcing contracts: days
- Enforcing contracts: procedures
- Investor disclosure

Commercialization/Go to Market

- Growth Competitive Index
- Starting a business: days
- Starting a business: procedures
- Registering a property: days
- Registering a property: procedures
- Borrower and lender rights index
- Productivity Index
- Economic Freedom Index
- Internet Penetration
- Wireless Penetration
- GDP Real Growth
- Percent population above poverty line

Chapter

3

Part 1: The Wireless Ecosystem

Wireless Ecosystem

Wireless Ecosystem: What Is It?

An ecosystem is a system whose members benefit from each other's participation via symbiotic relationships that lead to the mutual benefit of all parties. Two key characteristics of any biological ecosystem are that it is inherently self-sustaining through a value chain of participants, and that it evolves over time. A wireless ecosystem is no exception.

We use wireless technologies everyday, from cordless phones, TV remote controls and wireless local area networks at home, to cellphones, and RFID tags used to track medical equipment in hospitals.

While we use wireless in our daily lives, we don't really associate it with an ecosystem. So what is a wireless ecosystem? Descriptions of a wireless ecosystem range from the very technical to the futuristic. Scenes from the movie *Minority Report*, where the hero played by Tom Cruise enters a mall and his surroundings adjust accordingly from personalized greetings to ads, enabled through the combination of biometrics, presence, wireless communications, and multimedia coming together, provides for a good futuristic mental image. The future however, is not that far off. In mature wireless markets GPS enabled cellphones are used to deliver location sensitive promotional messages and mobile coupons to shoppers who enter a mall.

For the purpose of this report, we will stick to the tangible elements of the wireless ecosystem, and therefore define it as "an evolving system of technologies; standards; equipment, enablers and devices; services, applications and content; vendors, operators and end users." We will break the ecosystem down into its main components as part of a value chain and apply it to the purpose of this study. The purpose of this study is to position the wireless ecosystem, its value chain, and how Canadian companies contribute to it from regional, national and global perspectives.

Wireless Ecosystem Dynamics: Key Drivers

Despite its existence for well over a hundred years, wireless continues to evolve and grow. According to the International Telecommunications Union (ITU):

"Over the past 20 years, telecommunications has grown from a tool that facilitated person-to-person communications to the foundation that underpins a huge number of human activities, from international trade and commerce to health and education. Fast, reliable telecommunication networks are now a vital ingredient in the trans-border delivery of services such as banking, transportation, tourism, online information and electronic home shopping"[40]

The key drivers contributing to the growth in the wireless industry include:

Market Drivers

- ***Connectedness:*** *The ability to communicate with others, preferably independent of location and time*
  Connectedness is a major driver for all global participants in the value chain. There are two main categories: countries with established wireline infrastructure, where wireless is used for both productivity gains and as a means for convenience; and countries where wireline infrastructure is sparse. According to the ITU[41] over one billion people in the world, representing one-fifth of the entire population base still don't have access to *basic* telecommunications services. In 2003, tele-density per 100 inhabitants in developing countries was only 12 percent for wireline subscribers. For wireless, the ITU reported over 14 percent penetration per 100 inhabitants and a curve fast approaching that of developed countries (see Figure 3). This implies that wireless is being used by a majority of developing nations in the world to leap-frog their limited or non-existent wireline infrastructure in order to provide basic connectedness.

[40] Source: ITU: *ITU and its Activities Related to Internet-Protocol (IP) Networks: Chapter One*, April 2004. http://www.itu.int/osg/spu/ip/chapter_one.html

[41] Yoshio Utsumi, Secretary-General, ITU, June 16, 2005 *Connect The World Launch* http://www.itu.int/partners/pdf/SG_preso.pdf.

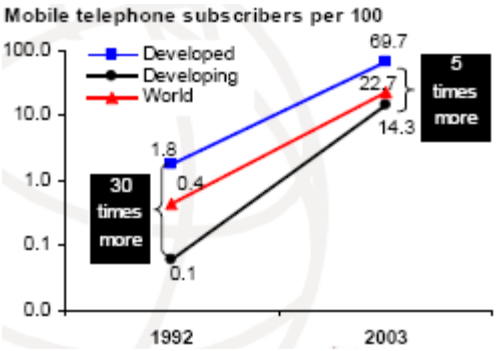

Figure 3 – ITU Numbers on World Connectedness for Mobility

- ***Quality of life:*** *The ability to have more time to do the things we like to do or the ability to meet the basic necessities of life*
  Improved productivity and the ability to perform tasks more conveniently are major drivers in most parts of the world, however, wireless has enabled many parts of the world to meet the basic necessities of life including wirelessly enabled telemedicine, and support for education programs.

- ***Infotainment:*** *In both developing and developed regions of the world, the need to be informed and be entertained is critical.*
  Boundaries of "at work" vs. "at play" are being blurred especially for knowledge workers, who desire access to their email, personal and calendar information, web browsing, or multimedia independent of where they are physically located. The need to be entertained, particularly in the youth segments is driving operators and vendors to focus on that segment. Wireless multimedia content such as games, music and videos is hot in most developed and mature markets. Messaging, content download, and email services have been key drivers for wireless data service growth thus far. Instant messaging, MP3 music, and streaming mobile TV content will represent a large majority of growth over the next few years.

- ***Reduction in barriers to entry:*** *Reduction in cost of infrastructure and advances in technology*
  Wireless technologies are reducing the barriers to entry for new entrants. Maturing technologies (2.5G cellular, GPS, basic cellphones, etc.) are becoming less costly to deploy and use, while new and emerging technologies such as WiMAX and VoIP over wireless are enabling new service providers, from global operators to municipalities and local governments to enter the market.

- ***Reduction in barriers to entry:*** *Deregulation and market liberalization*
  Deregulation and liberalization of the telecommunications market has been occurring steadily over the last few years in many developing countries. Parts of Middle East North Africa (MENA), countries in South East Asia, Eastern Europe, and Latin America have all witnessed significant levels of deregulation.

Deregulation as a requirement for European Union (EU) membership has pushed Eastern Europe far forward, particularly in wireless. Deregulation is a major catalyst for the growth of wireless as it can add healthy competition, leading to opportunities for export. Pakistan won a coveted award at 3GSM in Barcelona, Spain in 2006 in recognition of the advancements it has made in an effort to deregulate and create a competitive market for telecommunications.

Technology Drivers

1. ***Advances in communications technologies***
   Advances such as evolution from second generation (2G) to 2.5G and 3G are leading to:
   - better coverage and/or improved capacity;
   - ability to provide and monitor quality of service across different services in conjunction with 3G services;
   - enhanced security mechanisms;
   - overall support for higher throughput, even when in a moving vehicle;
   - ubiquity of service across different parts of the world; and
   - ability to better create and deliver services across different disparate networks (cellular, WLAN, Wireless Metropolitan Area Network [WMAN], etc.).

2. ***Evolution from circuit to packet-based networks***
   Wireless networks are leveraging the enhancements made in IP-based communications. This has lead to the support for IP-based services ranging from basic data communications to real-time multimedia applications. Several voice applications run over IP, including mobile VoIP and walkie-talkie-like Push-to-Talk (PTT) applications. This has not only made it easier for operators to create and deliver new services, but has also resulted in considerable reductions in equipment cost over that of traditional circuit switched networks.

3. ***Advances in devices***

   From cellphones to CPE like home wireless routers, advances in the processing capability of devices has been a major driver for uptake of wireless as a result of more functionality and reduced costs.

   The increased processing ability of devices, as predicted by Moore's Law, leading to the ability to pack more capability into handheld devices like cellphones – i.e. camera, video and GPS enabled phones has increased interest in mobile devices. For emerging markets, the availability of ultra low cost handsets (trending now to sub $30) has opened up wireless services to several new demographics globally.

4. ***Advances in software for clients and middleware***

Memory enhancements have allowed more software to be provisioned on the device. In addition to this, the flexibility to download applications on demand, and provision them over the air, is allowing operators to provide services that are more meaningful to users. These include the ability to download clients to enable m-commerce or to remotely diagnose a device for faults.

Wireless 101

Wireless communications in its strictest form is where electromagnetic waves (rather than some form of wire) operate across a spectrum of frequencies, carrying a signal over part or all of the communication path. The first wireless communications go back to 1896–97 when Marconi, building on the foundations laid several decades earlier by Maxwell and Hertz, sent a telegraph message wirelessly in Britain. The first voice communications over wireless happened in 1914. In 1935 Armstrong demonstrated Frequency Modulation (FM) and began the era of radio communications with voice communications for police as well as music and news transmitted over the air.

Wireless communications occurs across different frequency bands, known as the frequency spectrum. Wireless communications encompasses a large array of frequency bands ranging from 110 kHz for CB Communications through 450 MHz, 850 MHz, and 1800 — 2000 MHz for Cellular and PCS communications, to 12 GHz range for satellite communications, 40 GHz for microwave, and even higher for other applications such as radars.

Frequencies are mostly licensed and are allocated by governing bodies such as Industry Canada or the FCC. As such, different regions and countries around the world will sometimes have slightly different frequency assignments for similar applications. Vendors of wireless equipment will need to support not only the technology needed for the deployment but also the frequency range required in the country. For instance, while Personal Communications Services (PCS) — digital cellular mobile communications — network equipment in Canada will operate in the 1900 MHz range for GSM, this same equipment needs to support 1800 MHz in many other parts of the world including Europe, Asia, and Middle East and Africa (MEA). Wireless systems are also found in what is known to be unlicensed spectrum. Unlicensed spectrum is also allocated by governing bodies, however, it does not have the strict requirements and costs associated with licensed spectrum, it also generally operates on a first-come first-serve basis, with mutual coordination among multiple occupants of the same spectrum on channel assignments to deal with interference. WiFi (wireless LAN, 802.11) networks and cordless phones use the unlicensed spectrum for communications. The unlicensed spectrum may also be used by some service providers to support backhaul traffic, while some are considering its use for access, however this is for highly limited applications.

Wireless networks support a cell based topology. Wireless cells are used to depict the coverage area of the network. Networks can have a single cell (i.e. home WiFi network) or multiple cells (i.e. city wide PCS network). The wireless network has two key components to it, one is the base-station and associated network intelligence (cellular systems have complex intelligence and switching capability via a BSC/MSC combination, while simpler solutions such as WiFi employ similar functionality at much smaller and limited scale in a WiFi Router) and the other is the wireless device (i.e. a cellphone, a WiFi modem attached to the computer, etc.).

Wireless communications as is obvious by its name is communications without the use of wires, however, the extent of the ability of a user to communicate in terms of their mobility while doing so varies. Therefore wireless and mobile while sometimes used interchangeably in the public domain are different. Mobile communications is a subset of wireless communications and implies that the user has the ability to move (this includes driving across town). Therefore large mobile networks that have multiple cells, must support the ability to handoff a user driving across town from one cell to another. While this capability to support call handoffs and maintain the call or data session are the norm in cellular/PCS networks, these are not supported in WiFi or WiMAX (802.16) networks today. The term used in the industry is often “support for mobility.”

Figure 4 — Wireless 101 — A Brief Introduction to the Major Concepts

Before the ``Birth of Radio'' 1867–96

- 1867 — Maxwell predicts existence of electromagnetic (EM) waves
- 1887—- Hertz proves existence of EM waves; first spark transmitter generates a spark in a receiver several meters away
- 1890 — Branly develops *coherer* for detecting radio waves
- 1896 — **Guglielmo Marconi** demonstrates wireless telegraph to English telegraph office

``The Birth of Radio''

- 1897 — ``The Birth of Radio" - Marconi awarded patent for wireless telegraph
- 1897 — First ``Marconi station" established on Needles island to communicate with English coast
- 1898 — Marconi awarded English patent no. 7777 for tuned communication
- 1898 — Wireless telegraphic connection between England and France established

Transoceanic Communication

- **1901 — Marconi successfully transmits radio signal across Atlantic Ocean from Cornwall to Newfoundland**
- 1902 — First bidirectional communication across Atlantic
- 1909 — Marconi awarded Nobel prize for physics

Voice over Radio

- **1914 — First voice over radio transmission**
- 1920s — Mobile receivers installed in police cars in Detroit
- 1930s — Mobile transmitters developed; radio equipment occupied most of police car trunk
- 1935 — Frequency modulation (FM) demonstrated by Armstrong
- 1940s — Majority of police systems converted to FM

Birth of Mobile Telephony

- **1946 — First interconnection of mobile users to public switched telephone network (PSTN)**
- 1949 — FCC recognizes mobile radio as new class of service
- 1940s — Number of mobile users > 50K
- 1950s — Number of mobile users > 500K
- 1960s — Number of mobile users > 1.4M
- 1960s — Improved Mobile Telephone Service (IMTS) introduced; supports full-duplex, auto dial, auto trunking
- 1976 — Bell Mobile Phone has 543 pay customers using 12 channels in the New York City area; waiting list is 3700 people; service is poor due to blocking

Cellular Mobile Telephony

- **1979 — NTT/Japan deploys first cellular communication system**
- 1983 — Advanced Mobile Phone System (AMPS) deployed in US in 900 MHz band: supports 666 duplex channels
- 1989 — Groupe Spècial Mobile defines European digital cellular standard, GSM
- 1991 — US Digital Cellular phone system introduced
- 1993 — IS-95 code-division multiple-access (CDMA) spread- spectrum digital cellular system deployed in US
- 1994 — GSM system deployed in US, relabelled ``Global System for Mobile Communications"

PCS and Beyond

- **1995 — FCC auctions off frequencies in Personal Communications System (PCS) band at 1.8 GHz for mobile telephony**
- 1997 — Number of cellular telephone users in US > 50M
- 2000 + Third generation cellular system standards, Bluetooth standards, Wireless MAN (WiMAX)

Figure 5 — A Brief Historic Representation Of Wireless Adopted From University Of Florida Wireless Information Networking Group

The Evolving Wireless Ecosystem — Key Trends

The maturity level of wireless technologies and associated services varies from country to country. Thus far, wireless has been considered in many parts of the world as a means to facilitate basic person-to-person communications. However, because of the commercial viability of many technologies including RFID, Bluetooth, WiFi, GPS, and advances in both software and devices, wireless is evolving toward a seamless integration of disparate technologies and networks. Some interesting scenarios of the potential wireless offers in different facets of our lives is highlighted in Figure 6.

Disruptive Technologies and New Business Models

The wireless ecosystem is rapidly evolving as a result of various factors including disruptive technologies such as WiMAX and wireless mesh that address the last-mile challenges faced by many utelcos, municipalities, and WISPs in offering telecommunications services to end-users. Additionally, Packet-based voice (i.e. VoIP) and data applications can now be supported independent of access medium. Users can access services such as the Internet over wireline, cellular, and WLAN/MAN networks. Operators that offer both wireline and wireless services are also looking at reducing costs and OPEX by consolidating the infrastructure between both networks. Efforts are therefore underway towards Fixed Mobile Convergence (FMC). In parallel to this, wireless-only operators such as Vodafone are pushing for wireline replacement via superior wireless coverage and number portability.

The addition of several new players who are non-traditional service providers such as Disney and ESPN have also occurred through Mobile Virtual Network Operators (MVNOs). New technologies for Personal Area Networks (PANs), and advances in WLANs, as well as proximity devices enabled by RFID, have also been making progress as of late. In mature markets, operators are already deploying satellite and terrestrial based mobile broadcast networks (DMB, DVB-H) to support TV channels on mobile devices. All of these factors provide for both greater opportunities as well as new challenges.

Evolution towards Convergence

One of the main challenges in the industry is managing disruptive technologies and the resulting business models (i.e. VoIP and Skype), while running a profitable business. Many traditional operators are looking at convergence as a way to reduce costs, while creating more meaningful services that drive customer stickiness. Convergence includes:

- technologies that have been traditionally attributed to wireless, with those from other industries (IP/packet data — Internet, multimedia, consumer devices etc.);
- networks (wireless, wireline, satellite, cable, WLAN — WMANs — WWANs etc.);

- applications and services (location sensitive mobile-commerce); and
- end-user experience (same password, same look and feel, use any medium of access to do any task usually achieved in the past with a dedicated device — i.e. watch TV on a cellphone, listen to voicemail from your computer etc.).

Evolution Towards All–IP Multimedia (IMS/MMD)

Through various efforts under Third Generation Partnership Project (3GPP) and Third Generation Partnership Project 2 (3GPP2) and Next Generation Networks, there is a drive to move towards an all IP multimedia core network that supports the delivery of multimedia applications over various access media from cellular to WLAN to WMAN. IMS coordinated by 3GPP is concerned with ushering in a world where operators (fixed and mobile) and multimedia services interoperate seamlessly. IMS is an IP multimedia and telephony core network. IMS and MMD (Multimedia Domain) are defined by 3GPP and 3GPP2 standards bodies respectively, and are based on Internet Engineering Task Force (IETF) Internet protocols.

IMS provides standard reference architecture, and consists of session control, connection control and an applications services framework along with subscriber and services data. It enables new converged voice and data services, while allowing for the interoperability of these converged services between subscribers.

In the first phase IMS will run over mobile packet networks like General Packet Radio Service (GPRS), Enhanced Data rates for GSM Evolution (EDGE), UMTS, CDMA and in the second phase it will run on fixed (wireless), WiFi, WiMAX, xDSL, Cable and other broadband networks. The CDMA2000 3GPP2 version of IMS is called MMD (Multimedia Domain).

Service Creation and Delivery of Applications and Content

The ability to integrate services (i.e. messaging via Multimedia Messaging System [MMS] with location via LBS to deliver location sensitive messages, etc.), and to create and deliver multimedia rich, real-time applications rapidly, is a key driver for IMS and also for what is being positioned in the industry as Service Delivery Platforms (SDP). There are several specifications that are followed including OSA/Parley, JAIN, and web services to create and delivery services and applications. While SDPs are not standardized, they are defined from an ideal perspective to:[42]

- provide a complete ecosystem for the rapid deployment, provisioning, execution, management and billing of value-added services;
- support the delivery of voice and data services and content in a way that is both network and device-independent;

[42] The Moriana Group: Service Delivery Platforms and Telecom Web Services.

- aggregate different network capabilities and services as well as different sources of content, and allow application developers to access them in a uniform and standardized way; and
- optionally provide open and secure access to service capabilities for use by external service providers and enterprises.

There are several players in the wireless value chain that support a form of SDP; these include traditional network infrastructure vendors such as Nortel and Lucent, ISVs, System Integrators, and others.

The Wireless Ecosystem: A look at potential scenarios

Julia has been on a conference call all morning at home. She receives the call on her cellphone. The unique thing about this call is that it is being carried over her home WiFi network as a VoIP call. As Julia drives away the call seamlessly switches over from WiFi at home to the city's wireless MAN network, using least cost routing, which is cheaper than it being carried over the cellular network. On her way to work she drops her husband George off at the nearest train station.

The transit system has equipped all of its trains with GPS and allows commuters to determine if they are running on time or not. George determines that the train is leaving shortly. He runs on board, while the smart readers deduct the fare from his mobile commerce enabled smart-phone.

On the train, George downloads his email and calendar changes to his smart-phone. He decides to catch up on the latest news using satellite broadcast services offered by his wireless carrier. His smart-phone is multi-mode, able to support both cellular and broadcast services. The news this morning is of a large fire across town.

A fire truck passes Julie, who is a few blocks away from work, lights and sirens blazing, responding to an industrial unit fire. The fire chief on board takes advantage of city-wide deployed WMAN network and downloads blueprints of the facility from city hall. He can also view a live feed of the fire being transmitted by news helicopters on site. He determines that the fire is close to a chemical storage facility and warns the hazardous materials team of the possible danger of a chemical fire while still en route.

Burn victims are being transported by Emergency Medical Services (EMS) to the nearest hospital. En route to the hospital, the EMS staff relays patient info and vital stats to the hospital, where Dr. John reviews the information on his PDA. Dr. John leverages the hospital's WiFi network to page and SMS staff needed. He manages to track down where his burn specialist is, who happens to be working at a different facility today, but can guide other staff through the latest telemedicine capabilities equipped between the facilities. They are ready as the ambulance arrives.

Across town, Neil is working on his vineyard with the harvest season nearing. He is thankful for the wireless enabled sensor system he has in place, which gives him moisture and temperature information covering his entire site of 20 000 trees. This system allows him to meticulously water his grapes to prevent frost and create ideal grapes for consumption and wine production. He recalls how the system has helped him save money by allowing him to use precise amounts of pesticides and fungicides as well has giving him notice of when he should harvest

Joel, a foreman at a construction site, is looking forward to a productive and busy summer home building season. His construction site has WiFi, which allows him to access the company's inventory tracking system, and keep track of schedules or changes to inventory levels. He receives an SMS message informing him that the shipment of lumber, which was automatically ordered by his ERP system when it went below minimum levels, will be arriving within the hour. The inventory is kept in batches, which are tagged with RFID tags and each time a batch is used the RFID tag data is sent to the ERP software informing it of the decrease in inventory.

Figure 6 — A Day in The Life of People Living in a Potential Wireless Ecosystem.

SK Telecom's view of the future with Personal Area Network (PAN), WLAN, WMAN, WWAN, and broadcast networks co-existing is seen in Figure 7.

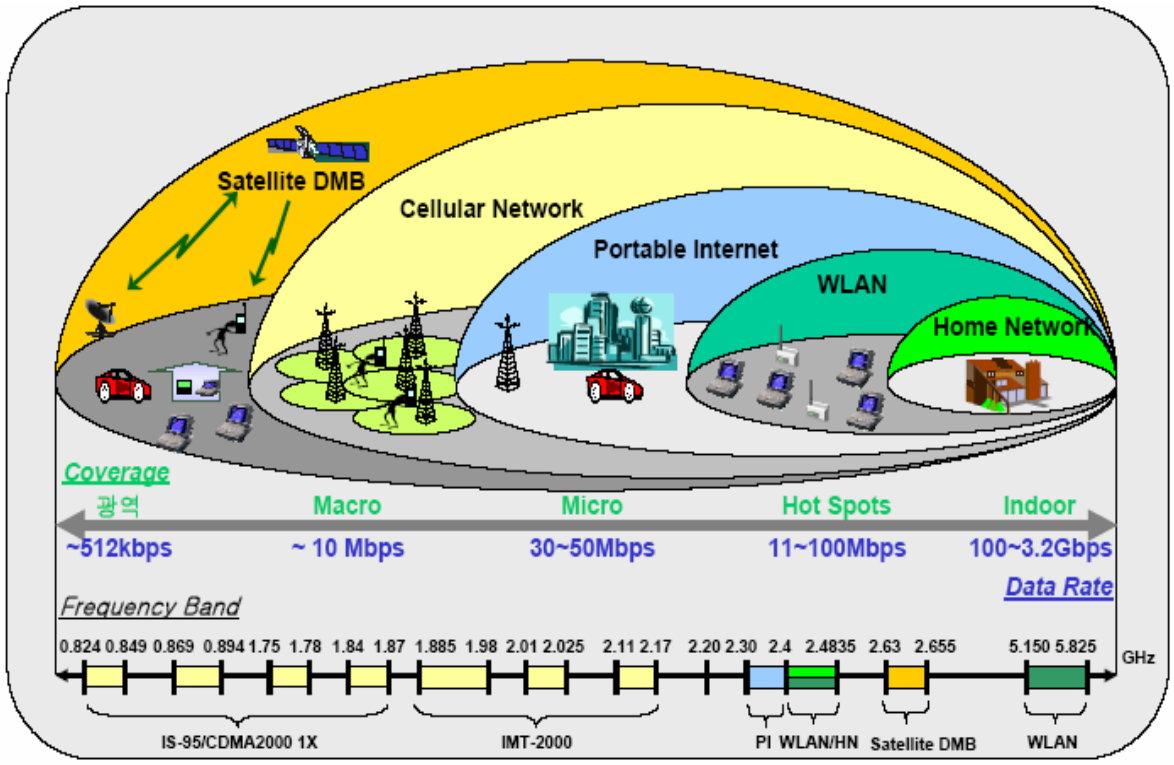

Figure 7 — SK Telecom's View on Converged Networks

SK Telecom has deployed DMB for:

- Mobile broadcast of TV channels to mobile phones;
- CDMA2000 and WCDMA cellular networks;
- WiBRO for metropolitan area coverage for high-speed mobile Internet access;
- WiFi for home and office usage; and
- RFID, Bluetooth, and NFC technologies for personal area networks.

The next phase of the evolution involves evolution to IP core that allows SK Telecom to leverage common IP core elements to provide services to customers irrespective of their mode of access.

Key Wireless Technologies — Role, Evolution and Applications

Wireless technologies are optimized for their use across several parameters, the three key ones being RF coverage, capacity, and the ability to support mobility. As such, wireless technologies and associated products are classified into three main categories, with each category defining the scale of mobility supported. Figure 8 highlights the three different characteristics of wireless systems:

1. Mobile — support for user and data session/call handoff and mobility management (i.e. cellular/Personal Communications Services (PCS) networks, 802.16 e, WiBRO, DMB, DVB-H)
2. Nomadic/portable — support for limited area portability, with no handoffs or mobility management (i.e. Metropolitan Area Networks (MAN) using current WiMAX – 802.16 a or wireless 802.11 based networks)
3. Fixed — support for personal area communications and movement of the device or receiver is highly restricted. (i.e. WiFi – 802.11, Bluetooth, or ultra wideband)

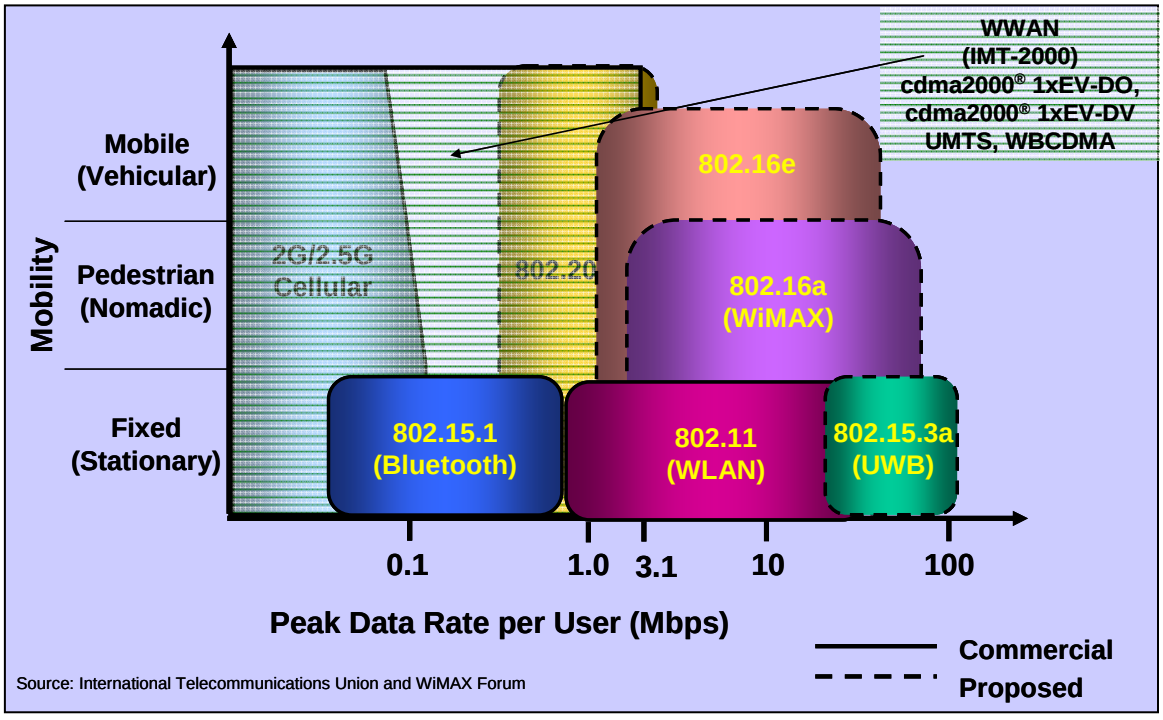

Figure 8 — The Three Main Levels Of Mobility Supported Across Wireless Systems

Cellular Technologies and Evolution

Mobile wireless systems are traditionally cellular networks, but also include satellite-based networks, two-way radio networks, and metropolitan wide area networks. This section focuses on cellular standards and corresponding systems.

Evolution Towards 3G — Key Players

Since 1985, the ITU has spearheaded the development of the next generation IMT–2000 standard, which provides a global platform on which to build 3G services such as fast data access, unified messaging and broadband access to multimedia services. The radio interface of the IMT–2000 standard was ratified in 1999. Industry organizations such as the 3GPP and 3GPP2 have developed technology specifications for 3G evolution to an all IP multimedia packet-based network (IMS/MMD), as well as the Radio Access Network (RAN). 3GPP2 work with other Standards Bodies around the world including European Telecommunications Standard Institute (ETSI), Association of Radio Industry and Businesses (ARIB), TTA, and TTC, etc. to define the technical specifications needed to implement 3G standards. The first 3G systems based on the IMT–2000 standard began operation in the year 2000. By 2003, more than 100 3G licenses had been awarded in more than 35 countries. The ITU continues to focus on systems beyond IMT–2000 and on considerations related to frequency spectrum needs, as well as the evolution from existing cellular systems to IMT–2000. The ITU–T is working on fixed mobile convergence initiatives.

The Open Mobile Alliance (OMA) was formed in 2002, with a mandate to drive mobile data services by specifying market driven service enablers that ensure service interoperability across devices, geographies, service providers, operators and networks.

Evolution Towards 3G — Key Standards and Technologies

There are three major cellular technologies deployed today, these are CDMA, GSM, and Time Division Multiple Access (TDMA) (see Figure 9). Of the three, TDMA (IS–54, IS–136) has an evolution path towards UMTS/WCDMA. CDMA (IS–95) based legacy networks have adopted an evolution towards CDMA2000. IMT-2000 has been defined by the ITU as the standard for 3G. IMT–2000 consists of five operating options, including 3 based on CDMA technology, known as CDMA2000, WCDMA (UMTS) and TD–SCDMA. The core network is moving towards an all IP based packet core across both the UMTS and CDMA2000 camps, spearheaded by 3GPP (IMS) and 3GPP2 (MMD) respectively. These bodies have also been active in defining the Radio Access Network (RAN).

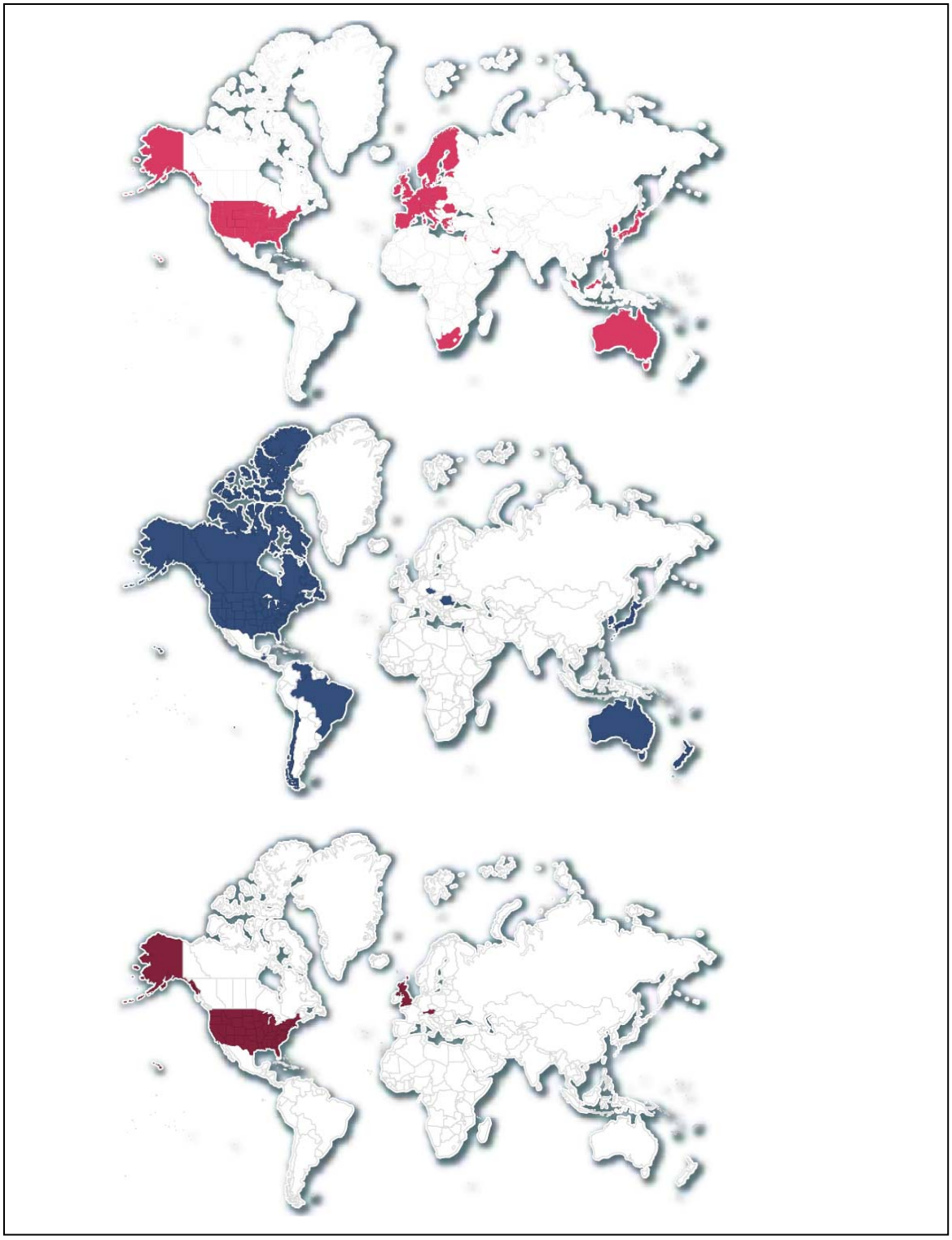

Figure 9 — Network rollouts by technology: W-CDMA/UMTS/3GSM networks in red); CDMA2000 based 3G EV-Do (in blue); HSDPA networks (in brown). Source: www.3Gtoday.com as of March 2006.

IMT–2000 has defined key requirements for third generation (3G) services (see Figure 10 and 11). These requirements include improved system capacity, backward compatibility with 2G systems, multimedia support, and high-speed packet data services meeting the following criteria:

- 2 Mbps in fixed or in-building environments
- 384 Kbps in pedestrian or urban environments
- 144 Kbps in wide area mobile environments
- Variable data rates in large geographic area systems (satellite)

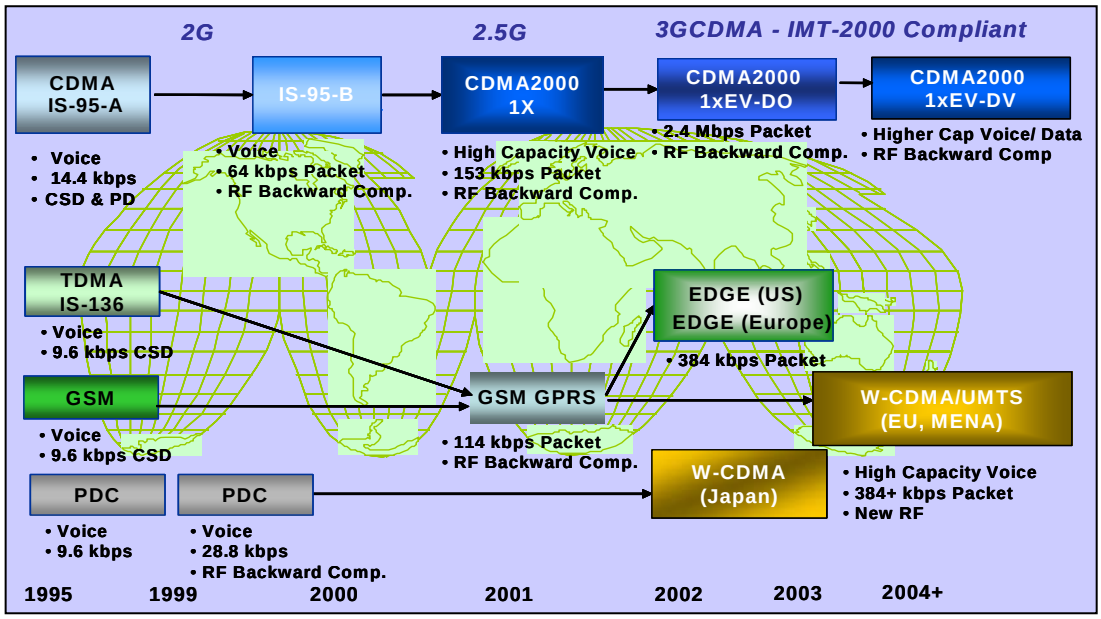

Figure 10 — Evolution of Cellular Systems to 3G

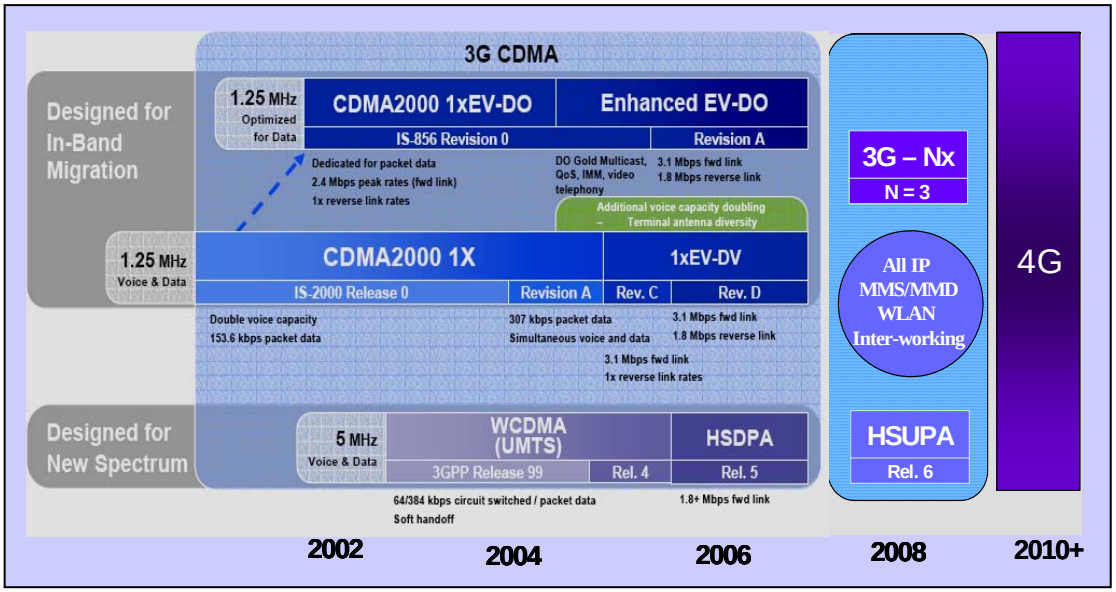

Figure 11 — Evolution of GSM, TDMA, and CDMA based networks to W-CDMA/UMTS and 3G CDMA, packet core data centric networks. [43]

[43] Adapted from QUALCOMM

CDMA is a spread-spectrum based digital communications technology pioneered initially by the US DoD and then adapted by QUALCOMM for commercial cellular use. The first standard for CDMA was IS-95 and the first systems came about in 1996–97 timeframe. The main advantages of CDMA included superior capacity, coverage and inherently better security and privacy. CDMA systems are mostly dominant in North America, South Korea and Japan however, it is also found in part of Latin America and Asia. The 3G UMTS or W-CDMA systems that are an evolution from 2G or 2.5G GSM and CDMA-based systems leverage CDMA or spread-spectrum communications for the RF air interface. According to the CDG as off third quarter (3Q) 2005, over 285 million CDMA subscribers exist across the globe.

Technology	Evolution	Application and Services
IS-95A standard was implemented for the original CDMA networks in 1996/97. It supports both a 13kbps and 8kbps EVRC vocoder for voice communications and basic 9.6 and 14.4 kbps data throughput. Most 2G CDMA networks in the world support IS-95A standard. IS-95 is deployed using a 1.25 MHz bandwidth, which is significantly larger than other alternatives (TDMA, GSM). All simultaneous user traffic is spread over this 1.25 MHz channel in CDMA using unique codes. Hence the terms spread-spectrum (signal spread over a spectrum) and Code Division, implying that codes are used to separate and identify users rather than frequencies or time.	**IS-95B** was the initial evolution of 95A, supporting data rates up to 64kbps via the use of fundamental and several supplemental channels, however this standard was implemented in a limited manner by some vendors including Motorola, and ignored by the majority of the operators in the world, who preferred to wait till 1xRTT(One Times Radio Transmission Technology) /cdma2000.	Voice capacity was greatly improved over analogue, and with the EVRC codes this improved even more. While circuit switch data as well as packet data is supported, it was seldom used, due to lack of compelling applications.
CDMA2000 (IS-2000, 3G-1x, 1x-RTT) was defined in the standards as the 3G evolution of CDMA IS-95A/B. While the standard defined both the 1x (which is 1 times the basic bandwidth of IS-95 of 1.25 MHz) and 3x (3 times 1.25 MHz bandwidth), vendors implemented 1x and the majority of operators across the globe support 3G-1x or 1x RTT or cdma2000 1x, all meaning the same thing. The major advantage of 1x over 95 is the doubling of Erlang capacity for voice traffic and support for up to 144 kbps packet data traffic, the average throughput is around 50 kbps. Over time, 1x has been called to 2.5G rather than 3G, as it doesn't support the full functionality of 3G. 1x is backward compatible with IS95.	**1xEV-DO Rev. 0** is the evolution of 1x and is optimized to support data traffic only in the initial phase. EVDO supports asymmetric data rates with a maximum throughput of 2.4Mbps in the forward link. The average throughput however is between 300–500 kbps. **1xEV-DO Rev. A+** these future revisions will support Quality of Service(QoS), which is important for real time, voice, and multimedia applications. They will also support a peak throughput of 3.1 Mbps in both directions. **1xEV-DV** supports both voice traffic, as well as data traffic with an average throughput for data similar to EVDO Rev. 0	**1x RTT** supports average packet data throughputs of 50 kbps, which is similar to the average throughputs experienced using a dial up modem on a POTS line. The support of packet-based routing and higher speeds has allowed several data applications from download of content like games and ringtones (advances in WAP, JAVA, and handsets, as well as availability of content all share the reasons growth) to email and messaging applications. While most could be done using IS-95, the higher throughput makes the transactions faster. **1xEVDO/DV** facilitates higher speeds, and with the eventual support for QoS it will be more beneficial for real time applications. SK Telecom pioneered the launch of EVDO in early 2002, and has used it for mobile TV and entertainment driven applications and content. They have realized that as EVDO is single-cast (i.e. each user gets their own stream), it's not efficient for broadcast type functions such as TV channels, they are therefore moving towards satellite and terrestrial-based broadcast solutions (DMB).

Technology	Evolution	Application and Services
CDMA2000-Nx (N=3, etc.) 3G-3x where the total channel bandwidth is 3x1.25 MHz or 3.75 MHz (deployed in 5 MHz band) is potential evolution of 3G 1x.	**N>3, 4G** commercial deployments are expected in the 2010+ timeframe, though Japan is likely to start trials sooner. 4G is expected to be based on Orthogonal Frequency Division Multiplexing (OFDM). Key aspects will be speeds greater than 100Mbps and a degree of inter-working/interoperability across WWAN, WMAN, WLAN.	**4G** will support significantly higher throughputs. Applications can basically include anything. The actual roll-out timelines are yet to be seen, given the anticipated high costs of devices initially.
GSM (Global System for Mobile communications) was originally started as a pan-European open standard to provide Europe with a single mobile technology, but was quickly made global. GSM is prevalent around the world and as of September 2005 there were over 1.5 billion GSM subscribers, representing approximately 77 percent of the world's cellular market. The growth of GSM continues unabated with more than 335 million new customers in the last 12 months, according to GSM World. GSM is based on a TDMA access scheme.[44]		
GSM is a digital cellular technology, based on circuit-switched communications that divides each 200kHz frequency channel into eight 25kHz time-slots. GSM operates in the 900MHz and 1.8GHz bands in Europe and the 1.9GHz PCS band in North America. Circuit switched data is supported up to 9.6 kbps, allowing the transmission of basic data services such as SMS. Through multi-band devices and SIM (subscriber Identity Modules) cards, GSM supports international roaming capability, allowing users to access the same services when traveling abroad as at home.	**GPRS** is the evolution to packet-based data over a GSM network. Throughput rates of up to 40 kbps are supported. GPRS has been deployed by most GSM operators around the world. **EDGE** provides up to three times the data capacity of GPRS. EDGE uses TDMA frame structure, logic channel and 200kHz carrier bandwidth as today's GSM networks, which allows it to be overlaid directly onto an existing GSM network. Most new GSM infrastructure deployments are also EDGE capable and nearly all new mid- to high-level GSM devices also include EDGE radio technology. EDGE has not been deployed as widely as GPRS. **WCDMA/UMTS/3GSM** is the evolution path for GSM and TDMA, this is discussed separately as these are deployed in separate spectrum.	**GPRS**, like 1x can support multiple applications from messaging, email, to games and music downloads. **EDGE** allows the delivery of advanced mobile services such as the downloading of video and music clips, full multimedia messaging, high-speed colour Internet access and emails.

[44] Some of this information has been collected from The GSM Association, GSM World for GSM and 3GSM/UMTS.

W-CDMA/UMTS/3GSM has been developed as an open standard by 3GPP and it uses a spread-spectrum based CDMA digital communications access technology for the air interface instead of the TDMA access technology used by GSM. It also leverages GSM-MAP for network signaling. As of the end of 2005, there are approximately 40 million subscribers of UMTS, mostly in Asia-Pacific and Western Europe. One of the biggest differences between UMTS and CDMA2000 deployments is that UMTS has required separate 3G spectrum, which has proven both expensive and a hurdle for those without it.

Technology	Evolution	Application and Services
UMTS Rel. 99 has been launched in several countries around the world; it supports a CDMA based air-interface and offers up to 384 kbps peak throughput. Initial deployments has not been very costly and not been considered to be highly successful given the cost of the spectrum, the infrastructure is all new and handsets were very expensive. Also the relative advantage of average data speeds of 100–150 kbps did not prove to be well positioned against CDMA2000's EV-DO technology, which supported average throughputs per user about 3 times as fast. This has lead to evolution towards Release 5, which supports HSDPA.	**3GPP Rel. 5 – HSDPA** is part of 3GPP/UTRAN-FDD Release 5 specifications. HSDPA is a software-based enhancement that boosts the air interface capacity of W-CDMA networks by 2 times and delivers a 4-5 fold increase in downlink data speeds. HSDPA has been trialed in Japan and part of Europe with commercial deployments starting in 2006. In Canada, Rogers Wireless as announced a trial as well. **3GPP Rel. 6 – HSUPA** (High Speed Uplink Packet Access) enhancements to the uplink data speed are being standardized in the 3GPP Release 6 specification. HSUPA technology is expected to be introduced in 2007. Jointly, downlink and uplink enhancements are referred to as HSPA (High Speed Packet Access) services.	Initial **HSDPA** services will be aimed at users with laptops using an HSDPA PC cards. The first 3G handsets and PDA's capable of HSDPA are expected in the first half of 2006 timeframe. Increased downlink and uplink speeds with **HSUPA** will increase the use of application and activities especially where data is shared between users, for example interactive multi-player games.

Evolution towards 3G — Key Services and Enablers

Wireless has come a long way from being just a tool to enable person-to-person communications. With the evolution towards 3G, greater emphasis has been placed on data and multimedia services. While revenues from data services are less than 10 percent in North America, in mature markets such as Japan and South Korea, data contributes about 25 percent to the bottom line for wireless operators. This has resulted in explosive growth and a demand for branded and custom applications and content. The most common data services are outlined below.

Messaging: SMS, MMS, IM, Chat

Messaging can be plain text messaging or picture/video MMS, and can be person-to-person, broadcast, or machine-to-person. While SMS has grown exponentially worldwide, MMS has not faired as well as a result of several challenges including differences in encoding and related interoperability issues. However, these are being addressed, and it is anticipated that MMS and long messaging will take over the growth of SMS over the next few years. The challenge with MMS in most countries has been a lack of compelling applications. Both South Korea and Japan have advanced these services considerably. While messaging is hot in Europe, it has just started to take gain ground in North America.

The hottest growing application outside of SMS is Instant Messaging, which has evolved from its PC-based domain to wireless Instant Messaging (IM). PC-based clients (Yahoo Messenger, MSN, AOL, ICQ, etc.) are popular, however both operator proprietary and other 3rd party clients are also making ground, including a service supported by VoIP provider Skype.

Enablers for messaging include SMSC, MMSC, and messaging clients for handsets. While not directly related to SMS and MMS, there is a trend toward Unified Messaging, where solutions look towards unifying the end users inbox, (voice mail, email, SMS, MMS, etc.) are being deployed. On the client side, advances in JAVA with MIDP2 and overall handset and network capabilities are also enabling the use of presence based messaging (similar to the PC experience).

Downloads and Streaming: Music, Videos

The download of content either as games, music or video clips represents one of the most popular consumer applications. Driven by the need for entertainment, mature markets such as South Korea and Japan have seen usage explode over the last five years. Of the various types of content, music is the hottest form of download; this includes ringtones, ring-back tones and music videos. Games are next, with the initial deployment of single player games now evolving to network-based multiplayer games, and further deployment of context based games (i.e. location sensitive games). Video downloads were introduced in mature markets like Japan and South Korea in 2002, with the introduction of video clips. These have since evolved to full-blown real-time video streaming applications. Video

applications are becoming more prevalent in North America now with the launch on 3G networks.

Enablers for downloads and streaming include both download servers and clients. Most downloads today are enabled through Wireless Application Protocol (WAP) in conjunction with a web browser on the handset, Java based applications are most prevalent. One alternative to Java is offered by QUALCOMM and is called Binary Runtime Environment for Wireless (BREW). BREW offers pre-tested and pre-loaded turnkey applications and content for CDMA service providers. These applications are developed in "C" programming language. For video streaming the MPEG4 is preferred as it does not require a hardware chip in the handset. Additionally for high-speed data, it is preferred that 3G networks be in place (Evolution Data Only [EVDO] or EDGE), but they are not a must.

Broadcast For Real-Time Streaming: TV and Radio

Mature markets have already evolved from EVDO to offer multimedia services that are resource rich using satellite and terrestrial broadcast networks. South Korea is championing its technology called DMB (Digital Multimedia Broadcast) while Europe is looking at DVB-H, an evolution of the existing non-mobile broadcast technology. While full multimedia broadcast networks aimed at mobile devices and handsets are still several years away for majority of the world, initial in-roads are being made in some markets with digital signage systems using existing terrestrial as well cellular systems to broadcast frequent updates for advertisements in cabs. QUALCOMM has announced plans to launch MediaFLO, a cellular-based broadcast technology, service and network.

Enabler challenges include optimization for mobility, frequency spectrum, and handset costs.

Location-Based Services (LBS)

Location-based services have picked up since 1999 with the commercially viability of GPS-enabled devices. In the US, an E911 mandate has been set by the FCC whereby services providers must support the ability to provide a mobile subscriber's location within certain distances in idle and active modes of operation. Despite its existence for some time, location services have been slow to catch on, and even in mature markets they are not very popular. Challenges include: accuracy of GPS inside buildings and in urban canyons; the linkage of GPS technology to the US DoD (some countries); and privacy (for end users).

Enablers for LBS have been well defined and include network-based components for Mobile Positioning (MPC) and Position Determination (PDE) in CDMA and GMLC/SMLC in GSM networks. Several handsets being produced already have GPS chipsets.

Mobile Commerce: M-Coupons, M-Payment, M-Wallet

Mobile Commerce (M-Commerce) has become a catch-all phrase for several mobile enabled commercial transactions. It can include the payment for services or content, smart payment cards/solutions, mobile coupons that offer discounts

towards purchase of goods, mobile advertising that leads to the purchase of goods, micro-payment solutions, and even wireless prepaid top up. M-commerce, like LBS has not experienced significant success, in fact, M-commerce has had more instances of failure than success.

Enablers for M-commerce, depending on what is being implemented, include partnerships with financial institutions for the processing of transactions, integration with existing payment solutions, including credit and debit cards, thick or thin clients on handsets, and m-commerce enabling backend servers relevant to the application at hand.

Packet Voice over Cellular: PTT, Mobile VoIP

Push-to-talk (PTT), and more recently mobile VoIP are gaining popularity. PTT follows Motorola's proprietary iDEN (Integrated Digital Enhanced Network) service, but offers it for non-iDEN customers. iDEN is offered by operators in a few countries including Canada, the US and South Korea, as well as some countries in Latin America including Brazil and Peru. While iDEN has been aimed at the blue collar worker market, PTT over cellular has been marketed more to young consumers as its popularity in the business arena hasn't been as successful as iDEN. PTT over cellular has had relatively poorer performance because call set-up delays. Mobile VoIP is also picking up in popularity on the heels of wireline VoIP, and Skype amongst others, whom offer a VoIP client for cellphones.

Enablers include PTT servers and handset hardware configuration to offer a push capability similar to two-way radios in addition to relevant software clients.

Summary

Initial deployments of 3G (UMTS/W-CDMA) networks in Japan and South Korea as well as in parts of Europe had their share of challenges with high license fees, coupled with the high cost of deploying networks and devices. To make matters worse, compelling applications that justified the high costs didn't exist. Another challenge faced in some markets was the manner in which base-stations communicated high-speed data over cellular to devices. For EVDO, EDGE, and High Speed Downlink Packet Access (HSDPA) today, transmission is single-cast to each user. As a result, operators that deployed EVDO in 2002 in South Korea experienced network-loading issues as users viewed real-time streaming videos for great lengths of time. Operators in South Korea and other parts of the world are now launching mobile broadcast services using satellite and terrestrial solutions to offer TV and audio channels. In South Korea, Digital Multimedia Broadcast (DMB) has been launched, whereas trials are underway elsewhere for other technologies including DVB-H. In the US, QUALCOMM has formed a separate company and is planning broadcast to cellular phones over its own network, called MediaFLO.

Despite early challenges, operators are deploying 3G and the overall market for 2.5/3G is targeted to reach US$50B by 2008.[155] There is also a push towards convergence and IMS, a result of the evolution of networks towards IP and the desire to efficiently create and deliver services to end users.

Mobile and Fixed Wireless Technologies and Their Evolution

The steady rise in broadband Internet penetration (both DSL and cable) has resulted in demand for wireless LAN networks in homes and offices. WiFi (802.11) allows users to be connected wirelessly to an AP that is typically tethered, eliminating the need for extensive cabling. WiFi adoption has been impressive and the market continues to grow as broadband penetration increases worldwide.

Broadband Internet connectivity has always been a challenge in rural and sparsely populated urban areas where the business case for deploying fibre and cable along with central offices (CO) in close proximity has been poor. This has meant that individuals and businesses in these areas have been forced to resort to dial-up or satellite for Internet connectivity. While cost effective, dial-up is slow and occupies the phone line, whereas satellite offers reasonable downlink access, but uses the phone line for uploading data. Satellite is also quite expensive, and poor weather conditions can wreak havoc on a satellite signal. WiMAX offers a good alternative for delivering last mile broadband Internet access. With throughput rates ranging from 50 to 70 Mbps and a coverage radius extending up to 50km (with line of sight) WiMAX has had its share of hype much like other new technologies. While the promise is still there, industry followers are a little more cautious than before.

The widespread use of WiFi and the demand for wireless Internet connectivity has resulted in the emergence of wide area WiFi networks, called Mesh Networks. These are networks that can link scattered WiFi AP's together as part of a single network. Options on technology mix envision some vendors supporting a mix of WiFi APs and WiMAX base stations. Mesh Networks are relatively new and open up the possibility for larger area deployments such as towns or cities in which case the networks are called Metropolitan Area Networks (MAN).

RFID is not a new technology and has been in use for several years for applications such as electronic toll collection, smart cards for fare payment or small ticket item payments. There has been a recent surge of activity in the supply chain and logistics area for RFID tags. This has been as a result of announcements by large retailer Wal-Mart, and the EPC Global (electronic product code) consortium, which has been pushing for EPC's to replace the traditional bar code system.

UWB is a wireless technology that is expected to replace Bluetooth and short distance wired solutions including USB, FireWire and audio/video cables. It offers several advantages over existing technologies including high throughput and low power consumption in addition to the convenience of being a wireless solution.

Below we take a closer took at each of the technologies mentioned here.

802.11 (WiFi)

The IEEE (Institute of Electrical and Electronics Engineers) 802.11 standard, and its variations, is commonly referred to as WiFi or Wireless Fidelity and is a popular choice for wireless LAN (local area network) deployments. Unlike cellular technologies such as CDMA and GSM, WiFi operates in an unlicensed spectrum thereby allowing anyone with an Internet connection to setup WiFi networks in their homes or businesses. There are three major variations of this standard in use today and they are: 802.11a, 802.11b and 802.11g.

802.11 and its Variations	Evolution	Application and Services
802.11a operates in the 5 GHz range with theoretical maximum throughput of 54 Mbits/s. This standard was ratified in 1999 and product shipments began in 2001. 802.11a is prone to less interference from other devices, such as cordless phones and microwave ovens given that it operates in the 5 GHz range instead of the 2.4 GHz range. This variant of WiFi has its limitations as the signal can be absorbed more easily by walls leading to poorer coverage than the b and g variation hence line of sight (LOS) becomes an issue, i.e. the 802.11a WiFi card must have a clear and unobstructed path to the router. **802.11b** operates in the 2.4 GHz and has support for maximum raw data rates of 11 Mbits/s. This standard was ratified in 1999 and products were quicker to hit the market as this variation was closer to the original standard known as 802.11 legacy. This variation of 802.11 caused the WiFi market to really take off as it provided faster throughput and equipment cost savings compared to the legacy standard. **802.11g** is the third variation, or modulation of the original standard, which was ratified in June 2003. It is quite similar to 802.11b as it operates in the 2.4 GHz range but achieves the same raw data speeds as 802.11a, 54 Mbits/s. This technology is being quickly adopted as it overcomes the shortcomings of both 802.11a and 802.11b and is backwards compatible with 802.11b. Most new WiFi access points are tri-mode now, i.e. with	**802.11n** is touted as the evolution to WiFi based LAN's. A new 802.11n Task Group (TGn) was setup by the IEEE in early 2004 to ratify this standard, which would support raw data rates of 540 Mbits/s. This would make 802.11n 10 times faster than 802.11a and g. At one point there were competing groups putting forth their proposals for this standard but the situation has changed since as the competing bidders have decided to merge their proposals. The new standard is expected to be ratified in 2006.	WiFi enabled a new realm of mobile Internet connectivity. Initially WiFi was used for wireless Internet within the vicinity of the AP's range. It has since evolved to include enterprise-wide and even metropolitan-wide wireless LAN's (WLAN). This has translated into productivity gains and reduced infrastructure costs for businesses. The introduction of WiFi enabled PDA's (Personal Digital Assistants) and mobile handsets have allowed various players to cater to this market and offer several applications and services. Enterprises can now save money on physical wiring as well as communication costs by routing their calls over the IP networks and offer users a degree of mobility, versus the traditional PSTN landline. There are some challenges with doing this, as specialized QoS measures have to be in place before VoWLAN (Voice over WLAN) can truly become an alternative means of voice communication. With the availability of WiFi hotspots everywhere, a new set of productivity and collaboration tools have also become possible as sales teams can be mobile and communicate effectively by having access to email and managing their contacts and calendars via mobile CRM applications such as Salesforce.com. This is in direct competition to the Blackberry™ offered by RIM, which have a push-based email system. WiFi has also enabled highly mobile individuals within the workplace such as doctors, nurses, warehouse employees, manufacturing plant workers to have access to the Internet on the go or have

support for a, b and g. **Range of an Access Point (AP)** is different for different modulations of the WiFi standard. 802.11b and g have a range of up to 150 feet or 46 meters indoors and a range of 300 feet or 90 meters outdoors. 802.11a has a much shorter range, due to the higher operating frequency, which causes more interference, which is typically one third of the range of 802.11b and g modulations limiting it to 50ft indoors and 100ft outdoors. **Security (802.11i):** Given that WiFi exists and operates in an unlicensed spectrum it allows anyone with a router compatible WiFi card to access an unsecured wireless network. This phenomenon raised the issue of security and privacy in the early days of WiFi. To tackle this problem the Wireless Equivalent Privacy (WEP) key was developed with the original 802.11 standard but had some security gaps. To overcome this problem, the 802.11i standard was ratified in June 2004. 802.11i uses the Advanced Encryption Standard (AES) providing enhanced security and privacy. **Quality of Service (802.11e):** In order for WiFi networks to provide the same QoS to mobile VoIP users as conventional cellular technology and to reduce latency in streaming multimedia content, a QoS standard had to be put in place. As of mid 2005, this QoS standard, 802.11e, was still in draft format. This standard would provide two added functionalities. The first would be the prioritization of certain types of traffic, e.g. VoIP, and second would be enhanced bandwidth control for applications, e.g. HDTV, allowing sections of bandwidth to be dedicated to specific type of traffic.		access to the Internet in remote areas. In a healthcare setting, doctors equipped with WiFi-enabled PDA's or Pocket PC's can access patient files off a database, make notes, issue prescriptions intelligently by cross referencing the medicine's side effects with the patient's condition. WiFi deployments in plants and manufacturing facilities has improved collaboration, productivity and led to cost savings.

Technology

Mesh Networks are Wide Area Networks (WAN) or Metropolitan Area Networks (MAN) of two topological types, full mesh and partial mesh topologies. In full mesh topologies, each node is connected to every other node in the network whereas nodes in partial Mesh Networks only connect to high data exchange nodes. Given the short range of Access Points (AP) and the need for a wired connection into each AP. Mesh Networks solve this problem by introducing backhaul nodes that are wireless and are devoted to transporting data (see Figure 12). There is no formal standardization of Mesh Networks yet, however the IEEE 802.11s task group is dedicated to this cause and a formal ratification of this standard is expected soon.

Mesh Networks enable large-area WiFi deployments allowing large enterprises and even cities to be wirelessly connected to the Internet. Less hardware is required for installation and users have the freedom to be mobile. Wireless MAN deployments can be complicated due to the lack of standardization and expensive if deployed over a large area. Many North American cities have been closely examining city-wide WiFi networks and there have been some deployments, for instance the city of Fredericton in New Brunswick. City-wide WLAN make sense when there is a lack of wired infrastructure for high-speed Internet access, when the area of deployment is small and immediate ROI is not a concern. There's also the threat to Incumbent Telecom Operators posed by municipalities deploying free WiFi access, as most people will opt for free WiFi instead of paying for broadband Internet services thereby impacting the incumbent telecom's revenues.

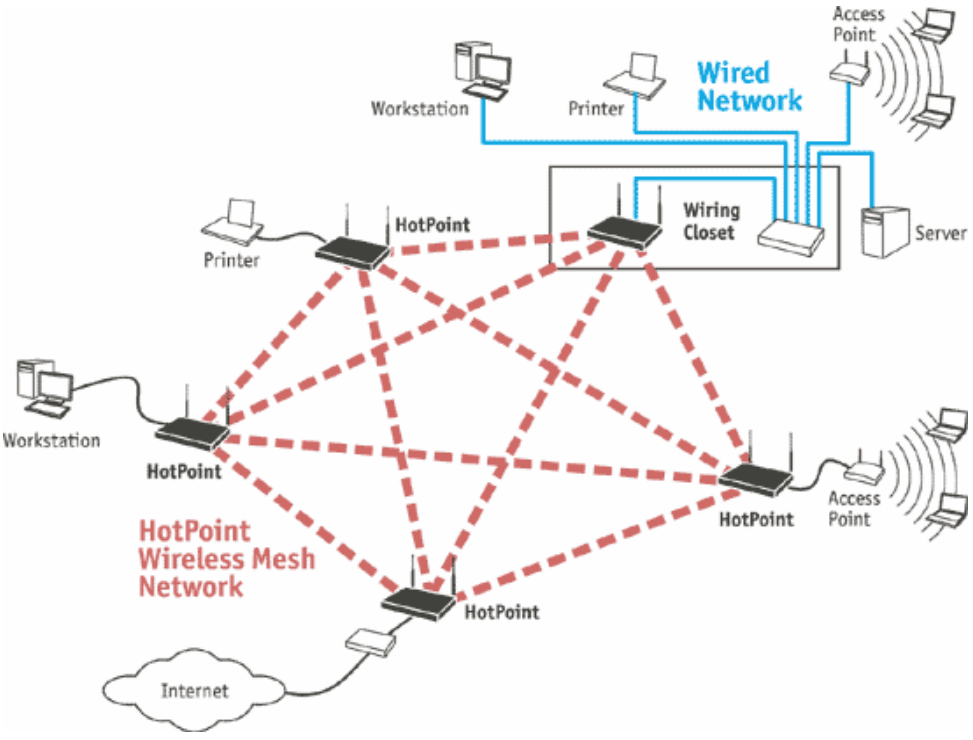

Figure 12 — Full Mesh Network[45]

[45] Source: http://ethernet.industrial-networking.com/images/art_images/ieb25wiremesh4.gif.

WiFi Summary

The proliferation of WiFi has spawned an entire industry for equipment and device manufacturers, application providers and related services providers.

The fact that many devices today such as laptops, PDA's, Pocket PC's, data cards and console gaming units have built-in WiFi support will continue to push the WiFi market to expand until there is true wireless broadband connectivity in homes, offices, restaurants, cafés, cities and even transit systems.

With widespread adoption of WiFi, new applications and services will start to become prevalent. Mobile VoIP is one that will be of interest to many. If QoS and privacy issues can be resolved, we will see a faster migration of voice connectivity from Public Switched Telecomm Network (PSTN) to VoIP. Conventional VoIP is being successfully adopted in homes and businesses and has brought on stiff competition for incumbent wireline operators. The emergence of dual mode WiFi/Cellular compatible handsets threatens to weaken voice ARPU for mobile operators. These operators will find themselves in unfamiliar territory having to compete with the likes of Skype, which offers free Skype to Skype user voice connectivity.

Mesh Networks take WiFi connectivity to a broader scale and allow city-wide and enterprise-wide deployments. The Republic of Macedonia recently announced that it would be blanketing a large area, close to 2000 square kilometres, with WiFi essentially making it the largest WiFi zone in the world. The zone will cover both urban and rural areas. This MAN will enable 90 percent of Macedonians to have wireless Internet connectivity with service available in 40 municipalities. Each municipality will be interconnected via fibre or wireless optic. The deployment is expected to continue till early 2007. Given Macedonia's challenging hilly terrain, if the mesh network is deployed successfully it will become a model for all large scale deployments and encourage other municipalities around the world to take the same initiative.

WiMAX (802.16)

The IEEE (Institute of Electrical and Electronics Engineers) 802.16 standard is aimed at the development of Broadband Wireless Access Technologies. 802.16 is commonly referred to as WiMAX. This technology was designed to serve as backhaul technology originally but has since shifted focus and is now being heralded as a Last Mile Access solution and a means to deploy FWA (fixed wireless access) and BWA (broadband wireless access).

Technology	Evolution	WiMAX Deployments and Application and Services
Wireless Interoperability for Microwave Access is part of the IEEE 802.16 standard. WiMAX is similar to WiFi as it delivers data wirelessly but with some differences. The original 802.16 standard slated WiMAX for operation in the 10 to 66GHz range but 802.16a broadened the spectrum to include the 2 to 11GHz range. WiMAX has both licensed and unlicensed bands unlike WiFi, which is unlicensed. WiMAX has higher throughput and is able to deliver services over larger distances than today's WiFi AP's. WiMAX's theoretical throughput values are claimed to be up to 70 Mbits/s with Line of Sight (LOS) service delivery possible up to 50km or 30 miles from a base station. These are maximum limits in favourable conditions; the more realistic numbers will depend on the deployments themselves. WiMAX is susceptible to interference as it operates in very high frequencies, which is why a typical setup of WiMAX would include a base station connected to a CPE located on rooftops, which would then route the service via a wired connection to the user. Real world testing has shown that WiMAX falls well short of its promises and tests conducted in the US by AT&T, this year, revealed that realistic throughput was 500 kbits/s to 2 Mbits/s at a distance of 3 to 5 miles. However, as of November 2005, UK-based Pipex is more optimistic after conducting initial trials of WiMAX and hopes that WiMAX will help it deliver 8Mbit/s broadband connection. There are other trials going on worldwide to determine the viability of WiMAX, which was originally slated to be backhaul technology only.	802.16 has evolved from its early days to include a broader range of operating frequencies in both the licensed and unlicensed spectrum. Recently the mobile WiMAX standard, 802.16e, was ratified by the IEEE. 802.16e differs from 80216d or 802.16-2004 (including HyperMAN) as the latter addressed communication between fixed WiMAX devices only. The 802.16e standard enables *mobile* devices to communicate with a WiMAX base station. Full Mesh Networking capability will be added to the existing WiMAX standard soon. WiMAX certification is underway and is being conducted in five waves.[46] The certification process is two fold, ensuring that the product, be it a base station, CPE, etc, complies with the standard and secondly that is interoperable with other vendors' products. The first three certification waves will address the 802.16–2004 standard and are expected to be complete by the end of 2006. The first wave of these certifications tackles air interface interoperability and was expected to have been completed by the end of 2005, however this timeline has slipped. The second phase will focus on QoS, security and fixed outdoor CPE's. The final phase of the 802.16–2004 certification will target indoor CPE's and	After a 6-month trial, Telabria, a regional Operator in the UK launched WiMAX services, as of September 2005, in Kent offering symmetrical broadband speeds (i.e. the same uplink and downlink speeds) of up to 10Mbps to both businesses and residential consumers.  *Source: Telabria* Speakeasy, one of the largest, nationwide ISP's in the US which offers broadband services to over 45 000 customers nationwide, recently deployed WiMAX, in collaboration with Intel and Alvarion, on top of the Seattle Space Needle. This venue for deployment was chosen due to the mix of challenges such as weather, terrain, water and tall skyscrapers. The company's mindset was that if this rollout was successful, given the challenging terrain, and if adoption rates were high then WiMAX would be successful in less

WiMAX has tremendous potential, if it lives up to expectations, as a BWA or Fixed Wireless Access (FWA) technology for last mile solutions and backhaul links for Operators. Given that WiMAX can be deployed in an unlicensed band, it opens up the market to non-conventional players in the broadband market. These non-traditional players, which would operate as Wireless Internet Service Providers (WISP) can take the shape of Municipalities, ISP's, Competitive Local Exchange Carriers (CLEC), Enterprises such as Business Depot who want to service clients in business parks or industrial areas and others. The announcement by Intel to incorporate WiMAX into its chipset destined for laptops is a positive disruptive force for WiMAX deployments. **WiBro (Wireless Broadband)** is the South Korean alternative for WiMAX, which has the backing of the South Korean Government. WiBro operates in a licensed band and has built in support for mobility as it was originally developed with the intention of becoming an alternative for 4G cellular technologies however it has since joined WiMAX. In November 2004, Intel and LG Electronics decided to ensure interoperability between WIMAX and WiBro. WiBro's theoretical maximum throughput is 30 to 50 Mbits/s at a range of 1–5 Km. WiBro has built in QoS, which allows it to deliver streaming video with low latency. This feature is useful for supporting applications such as VoIP.	PCMCIA cards in fixed and mobile environments. The last two waves will tackle 802.16e certification, expected to be completed by the end of 2007, and will ensure complete mobility with WiMAX.	challenging environments. WiMAX can be used as a backhaul connection for cellular technologies or for WiFi when deploying a mesh network. WiMAX can deliver wireless connectivity over a large area to residential users and businesses thereby enabling broadband Internet connectivity, video, VoIP, mobile VoIP (with the new 802.16e standard) and IP-based applications and services.

[46] According to Monica Paolini of Senza Fili Consulting, *The Evolution of WiMAX Certification* October 2005, http://www.senzafiliconsulting.com/downloads/SenzaFili_WiMAX_Certification.pdf.

WiMax Summary

There has been a lot of hype surrounding WiMAX over the past two years. This hype intensified when Intel joined the WiMAX initiative back in 2003. It was anticipated that by the end of 2005 WiMAX would be widely deployed, but that didn't happen. This led many to question the promise of WiMAX, delayed product certification, and poor trials results have failed to remedy the situation.

However, there is some good news. As outlined above the WiMAX (802.16e) standard has been ratified with trials expected to begin by mid 2006. The mobility aspect of WiMAX will definitely push the technology further as a last mile access solution because it will allow WiMAX operators to deliver triple play with the possibility of VoIP, broadband Internet and eventually TV and other applications. Given that WiMAX has low latency and QoS built into the standard, the quadruple play is a possibility in the future.

Successful trials and deployments will help boost WiMAX's stocks. It will be interesting the see the outcome of the WiMAX deployments mentioned above. Telabria's success will speed up WiMAX deployments in the UK and Europe whereas Speakeasy's success will ensure wider deployments in North America.

With WiMAX comes the threat of new market entrants. WISP's (wireless Internet service providers) will become prevalent and start bundling their broadband Internet offering to include VoIP and other data services, thereby challenging the incumbent telecoms. While IPTV has been touted by some as one of these applications over WiMAX, the capabilities are yet to be proven and are expected to be limited. Utelcos or utility telecoms are another major threat. Most utility companies have extensive fibre in place in rural areas but haven't been able to leverage it. With WiMAX, however they will be able to offer last mile access solutions of their own. Smaller scale WiMAX deployments in business parks, where high concentrations of businesses are found, are also possible. All of these are threats to incumbents who will either have to be the first to market with these solutions or change their strategy to scale back operations and become a bandwidth and infrastructure provider instead.

802.20

The IEEE Mobile Broadband Wireless Access (MBWA) group is responsible for the 802.20 is the standard, which is yet to be ratified. The 802.20 enables mobile broadband at high speeds. It operates in a licensed band below 3.5 GHz with an all IP-based architecture. The technology can support connection speeds of 1.5 Mbits/s in devices moving over 120 km/hr and a typical cell range is about 15 km.

This technology is still in its early stages of development and is not expected to be standardized until after 2007. When it is standardized however, it will have to compete with 802.16e, the mobile version of the WiMAX standard, as well as relatively entrenched cellular high-speed data overlays. The only advantage that 802.20 holds is that it can support high data rates for extremely fast moving devices, making this a useful technology for deploying broadband in high speed trains.

Market Drivers for WiFi, WiMAX and Mesh Networks

- Standardization and Interoperability: With standardization, equipment vendors will manufacture interoperable devices.
- Cost of Deployment: This will be of major concern to enterprises and municipalities who will want to deploy a good solution at the right cost. While the cost of WiMAX CPEs is expensive today, it is declining and expected to be considerably lower over the next few years.
- Good User Experience: Poor user experience will lead to low adoption rates and disappointing ROIs.
- Successful WiMAX and Mesh Network Deployments: More instances of successful WiMAX and Mesh Network deployments are needed to drive economies of scale.

RFID

RFID technology allows quick and automatic identification of goods, animals and even human beings. It works by using a transceiver to detect and translate the information present on RFID tags or transponders, which are small objects placed on the items of interest for the purpose of identification. All RFID tags are chips with built in antennas, which allow them to communicate with the transceivers. There are two types of RFID tags: active tags, which require an internal power source and passive tags, which derive their power from a transceiver's radio signal once it comes into its range. RFID tags come in a variety of shapes and sizes and are more versatile than today's bar codes, which they hope to replace. For instance, RFID tags are capable of storing much more information than bar codes, they last longer and have read/write capability.

History and RFID Tags

History: A form of RFID technology was used in the second world war called IFF (Identification, Friend or Foe) for aircrafts. IFF used long-range transponders in an era when radars were becoming popular for military applications. Electronic Article Surveillance (EAS) for anti-theft purposes came in the 1960's. This was the first commercial use of RFID. Over the 70's, 80's and 90's RFID usage expanded to tracking items such as cargo, buses and even highway toll collection. In the latter's case, cars could drive by at highway speeds without having to stop to pay the toll for using the highway.

Passive RFID Tags can be quite small in nature given that there is no need for a power source to be on board. The world's smallest passive RFID tags can be thinner than paper and less than a millimeter in length and width. Their small size allows them to be discrete and almost invisible. The moment these tags come into contact with a radio field they power up before transmitting a signal. The typical range of these tags is between 2mm and a few meters depending on the transceivers frequency. The small size combined with the lack of an on board power supply makes passive RFID tags inexpensive to manufacture with the potential for an unlimited life.

Active RFID Tags do sport on an on-board power supply, which enhances the signal strength and allows the tag to transmit a signal over a greater distance, usually several meters, than passive RFID tags. The power supply means that active tags are slightly

Evolution

The Gen 2 EPCglobal standard was ratified in December 2004 and will be the basis for any ongoing development of EPC technology.

Gen 2 has several key advantages over previous generation RFID tags

- Gen 2 follows an open standard, which will ensure RFID tags become cheaper
- Interoperability, which will allow RFID tags and readers from different vendors to interoperate
- Smaller chip size
- Improved Tag Identification and Reliability
- Faster read rate: 10 times faster than previous generation tags
- Enhanced memory allowing for more information to be stored on a single chip
- Improved security as information can be encrypted and each tag can have an associated password
- An ability to permanently decommission an RFID tag

Application and Services

RFID can be used in a variety of ways for a multitude of industries ranging from manufacturing to healthcare to the military. Examples of applications of RFID include: tracking items and shipments, passport and other identification, logistics and transportation, warehousing, patient monitoring, animal identification, smart cards for transit fare payment and smart keys for unlocking doors.

RFID tags for animal identification are low frequency tags, which use two frequencies namely 135 KHz and 134.2 KHz. Higher frequency tags are used in identification badges and for tracking items and apparel in stores and libraries. Ultra High Frequency (UHF) RFID tags are used in warehousing and logistics for tracking pallets, containers and transport trucks.

RFID is also used in electronic toll collection. The 407 electronic toll road (ETR) has antennas setup at each highway entrance and exit point, which interact with transponders in vehicles. The vehicle, with a transponder, is accurately identified even if it passes these antennas at highway speeds.

RFID is also used extensively in smart cards or contact less payment solutions. These smart cards can be used as electronic money and store payment information and are extensively used for public transit, the Octopus card in Hong Kong, and mobile commerce (m-commerce), i-mode FeliCa in Japan. In most cases, users just have to hold their smart card or m-commerce enabled handset in close proximity to the reader.

RFID is also enabling smart key or electronic key systems. FeliCa handsets

bigger in dimensions than passive tags and more expensive to manufacture. They also have a shorter lifespan of 10 years compared to passive chips EPCglobal is the consortium that has been pushing for the standardization of Electronic Product Code (EPC) using RFID technology. The consortium is comprised of large multinationals such as Gillette, Proctor & Gamble, Johnson & Johnson, Wal-Mart and Hewlett-Packard. EPC RFID tags for product tracking were created with the intent to replace bar codes, which can have limited use and shorter life spans. RFID tags can withstand poor weather conditions and be embedded into the product itself. RFID tags have read-write capabilities and the ability to store more information than traditional bar codes, which can carry limited information and have no write capability. Bar code readers have a shorter range than most RFID chip readers and cannot be processed in batches like RFID tags.		offered by Japan's NTT DoCoMo have a Sony IC (integrated circuit), which operates at13.56 MHz and can be used as a key for the home or office in addition to being used as e-money.

RFID Summary

RFID technology has been around for a long time but most of the recent activity can be attributed to the US Department of Defense and businesses such as Wal-Mart who have decided to track inventory using RFID. In January of 2005, many of Wal-Mart's top suppliers began tagging their products with RFID with another 200 suppliers expected to join them in 2006. Fifty smaller suppliers have also voluntarily started using RFID. Wal-Mart is expected to continue equipping its stores and distribution centers with RFID technology well into 2006 and 2007 thereby driving wide adoption. Retailers and manufacturers are all monitoring Wal-Mart's progress closely and hope to learn from its experience with RFID.

Near Field Communications (NFC) and contact-less payment solutions have become more common over the years in which RFID plays a part. Many transit systems around the world are already using some form of a smart card payment solution. The Octopus smart card , used widely in Hong Kong, has been in use since 1997. It has since evolved to allow users to pay for small ticket items at restaurants, cafés and parking meters for instance. Octopus cards can also be used as electronic keys for homes and offices.

RFID is going to start becoming more pervasive as US citizens will be issued RFID enabled passports beginning October 2006. The passports will transmit information such as the passport number, the holder's name and their date of birth. The information on the RFID chip will be encrypted and the passport will be covered with a thin metal shield to protect the passport holder's privacy. Given that the US government is implementing this measure, there's no doubt that other countries around the world will follow suit.

The widespread use of RFID is generating some privacy concerns. These are mostly concerns from individuals who feel that retailers will now be able to gather and analyze more information than ever on consumer buying patterns. RFID tags can be read from further away than bar codes and carry more information including time and date of purchase. There are also ethical concerns associated with tracking children, patients and prisoners for instance.

RFID Market Drivers:

- Regulation, Security and Privacy: Regulation always plays an important role in the development of any technology. The decision by the US government to equip all passports with RFID as early as October 2006 will help drive the RFID market as other governments worldwide will follow in the US's footsteps. Regulation is also important to protect the privacy of the end user who will want some control of the information that is being captured.

- Standardization and Interoperability: Standardization and interoperability are important when dealing with hardware as all companies along the value chain will want to ensure that their RFID system will interoperate with any RFID chips that they come into contact with. Interoperability also plays a role in m-commerce or smart cards where electronic payments are involved. Users will want to be able to use their smart cards, speed passes or mobile phones at a variety of retailers and have the ability to add credit to their accounts via their bank account or credit card.

- Lower Cost: Cost always plays an important role as enterprises want to ensure that they are getting the best price for RFID tags, middleware, application servers and the applications themselves.

- Strong Business Case: A strong business case for RFID in EPC is yet to present itself. As it stands, growth in EPC has primarily been driven by demands from large enterprises and governments to their suppliers. A genuine business case for RFID needs to be established for all players across value chains in vertical markets.

- Ubiquity: Ubiquity will also be a key driver for RFID adoption. This is applicable to EPC as well as the other applications for RFID such as smart cards and m-commerce.

- Ease of Use: RFID solutions must be user-friendly otherwise usage rates will be poor and the technology will fade away.

Ultra Wideband

UWB is seen as the evolution of Bluetooth and a potential replacement for many short distance wired solutions such as USB, IEEE FireWire and audio/video cables. It is a wireless PAN or Personal Area Network enabling technology, which operates over short distances (10 meters or just over 30 feet) at very high throughput speeds, 480 Mbits/s at a range of 10 feet. Another characteristic of UWB is that is has low power consumption.

Technology	Evolution	Application and Services
Ultra Wideband operates in a very broad spectrum ranging from 3 to 10 GHz. It works by transmitting extremely short bursts of pulses. These bursts are usually in the nanosecond time frame and short burst combined with the large bandwidth range allows UWB to have extremely high throughput. UWB has low power consumption and demonstrates the potential to replace all short-distance wired data communication ranging from USB cables to coaxial cables.	The IEEE 802.15 work group deals with PAN technologies and the 802.15.3a group is involved in the standardization of UWB. UWB is the evolution of existing PAN technologies such as Bluetooth and will also replace short distance wired technologies such as USB, FireWire and various audio/video cabling. The 1394 Trade Association (TA), a group assigned to FireWire, gave its permission in late 2004 to allow USB to wirelessly interact with FireWire devices.	UWB can replace all existing short-distance wireless technologies including Bluetooth for cellphones and PDA's. Other applications include cordless phones, wireless keyboards, game controllers and pointing devices like a mouse or tracker ball. UWB will replace non-electrical wiring such as FireWire and traditional audio/video cabling within a range of 10 feet. This would include wiring around TV sets, stereos and A/V equipment. USB 2.0 will be replaced by UWB, which will enable devices dependent on USB to connect wirelessly. Standards being developed will ensure that one UWB controller will be able to wirelessly control up to 127 devices.

Ultra Wideband (UWB) Challenges and Market Drivers

- Regulation: Challenges include uncertainty with regulation addressing spectrum concerns.
- Standardization and Interoperability: Users will want the flexibility of buying any product and knowing that it will work with their existing UWB solution. Backwards compatibility with USB and Bluetooth will also be important as users may be using a combination of devices relying on old and new PAN technologies.
- Ubiquity: The prevalence of UWB compatible devices and dongles that interoperate will push UWB adoption rates higher.
- Cost: Low cost will help drive user adoption if the above latter two requirements are met.

Market Size and Market Share

The wireless market size and market share across the world should be examined across the world. Areas to examine include:

1. Current and projected cellular market penetration and market share for voice and data services.
2. Measurement of revenue with a focus on equipment spending and market share across the following technologies:

    a. Cellular Equipment (3G/UMTS, Personal Digital Cellular [PDC], TDMA and iDEN)
    b. Wireless Handset shipments
    c. Mobile Data
    d. RFID including Active/Passive Tags and Card Readers
    e. 802.16 WiMAX
    f. 802.11 WiFi, Meshed Networks
    g. Ultra Wideband

3. Current and projected revenue for mobile data applications and content, with a focus on messaging, content, entertainment and mobile commerce in defined countries and regions across the globe.

Cellular Penetration and Market Size

To showcase an overview of the global cellular market, KAZAM examined cellular subscriber numbers and penetration rates in countries and regions worldwide. Europe shows the highest penetration rates in the world with most Western European countries and some Eastern European ones approaching 100 percent and higher (see Figure 13).

KAZAM projects the global number of cellular subscribers to reach three billion by 2009 (see Figure 14).[47] The growth in subscribers is expected to come mainly from MEA, Latin America, Eastern Europe, and from China and India, as well as other emerging markets in Asia-Pacific. Each of these regions will experience a compound annual growth rate (CAGR) of 8 percent or greater between 2006 and 2009.[47] Due to the high penetration rates in Western Europe, KAZAM already observes growth leveling off. North American markets will experience a CAGR of just over 5 percent between 2006 and 2009 as they continue to mature[47].

Operator revenues in mature markets are expected to be driven by enhanced services. Revenues for emerging markets will mostly come from new subscribers using voice services. By 2009, KAZAM anticipates that Western Europe will represent a quarter of all operator revenues for cellular services in the world, followed by North America and Asia-Pacific (excluding India and China) at one fifth. Due to significantly lower ARPUs and on-going downward pricing pressures, KAZAM anticipates that operator revenues in China, India and MEA will represent less than one fifth of worldwide operator revenues. Latin America and Eastern Europe will make up the remaining 15 percent of the cellular operator worldwide revenues.

Over the next three years, there are opportunities in mature markets for content, data services and applications, and in emerging markets for network infrastructure and capacity expansion. Opportunities for infrastructure and handset sales will become increasingly competitive, which will put downward pressure on pricing.

[47] KAZAM Cellular Subscriber and Penetration Rate Forecasts, 2006.

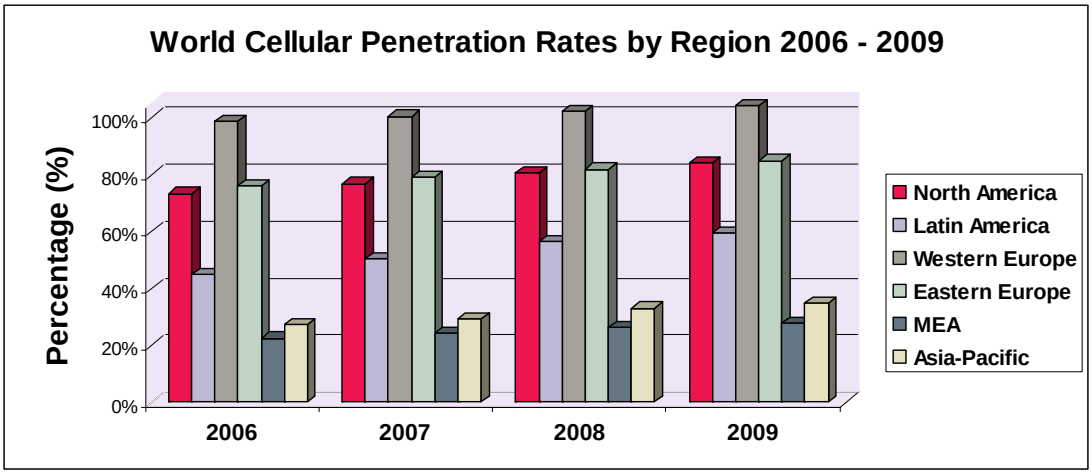

Figure 13 — World Cellular Penetration Rates by Region 2006–08[47]

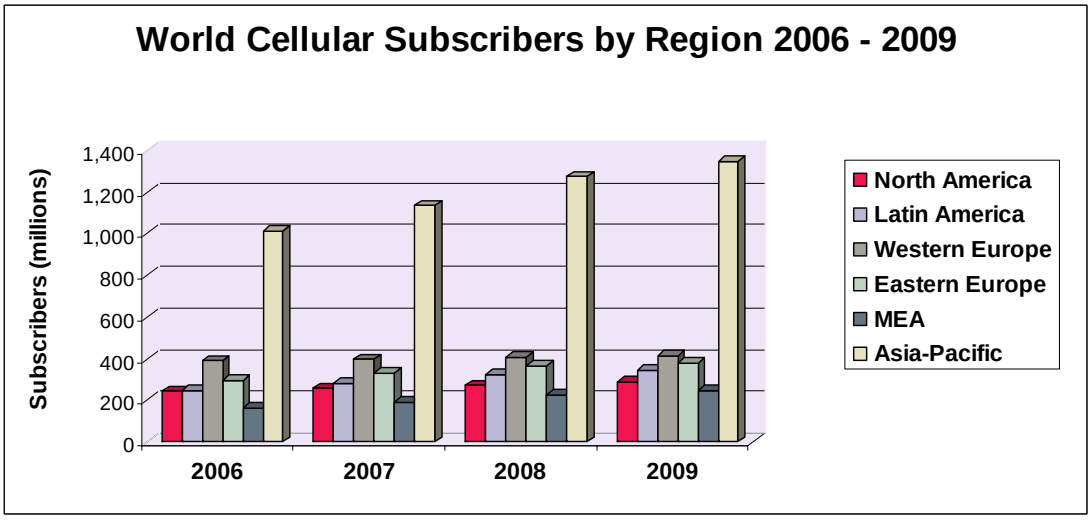

Figure 14 — Worldwide Cellular Subscribers by Region 2006–09[47]

North America

The North American market (US and Canada) lags the Western European market for cellular penetration rates (see Figure15). The penetration rate for Canada, at approximately 52 percent in January 2006 falls behind the US penetration rate, which is at 67 percent.[48] This offers opportunities in both countries for growth in the number of subscribers (see Figure 16). Wireless operators in North America are expanding the capacity of their networks to accommodate growth in both subscribers and network traffic as a result of mobile data services.

[48] CWTA, CTIA and Operator Reports.

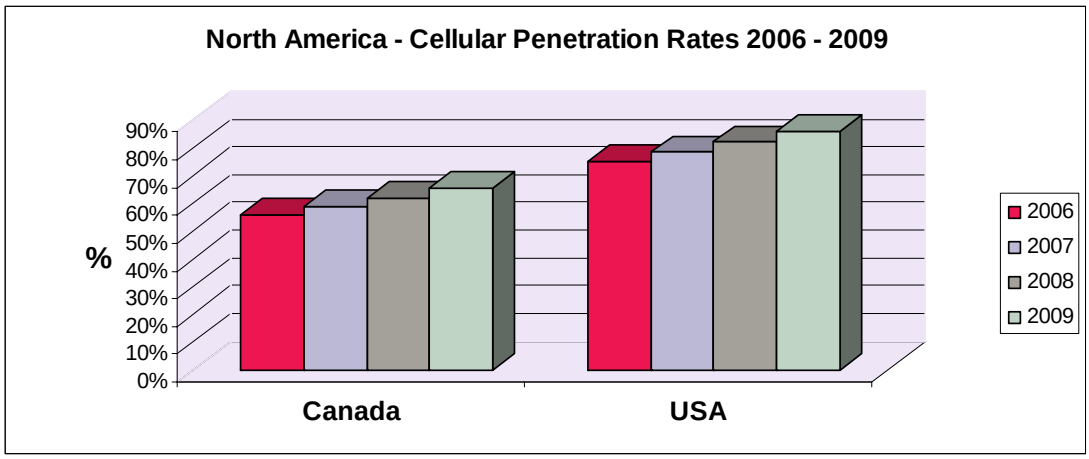

Figure 15 — North America Cellular Penetration Rates 2006–09[47]

North America represents the lowest percentage of prepaid subscribers in the world and KAZAM anticipates this figure to grow to just over 13 percent by 2009. KAZAM believes the region will exhibit the highest worldwide subscriber ARPU at US$60 (per month) by 2009, well ahead of its closest competitor, Western Europe, expected to be at approximately US$45 by 2009. Note that in Europe, only the calling party pays, whereas in North America airtime charges apply to both calling and called parties in most cases.

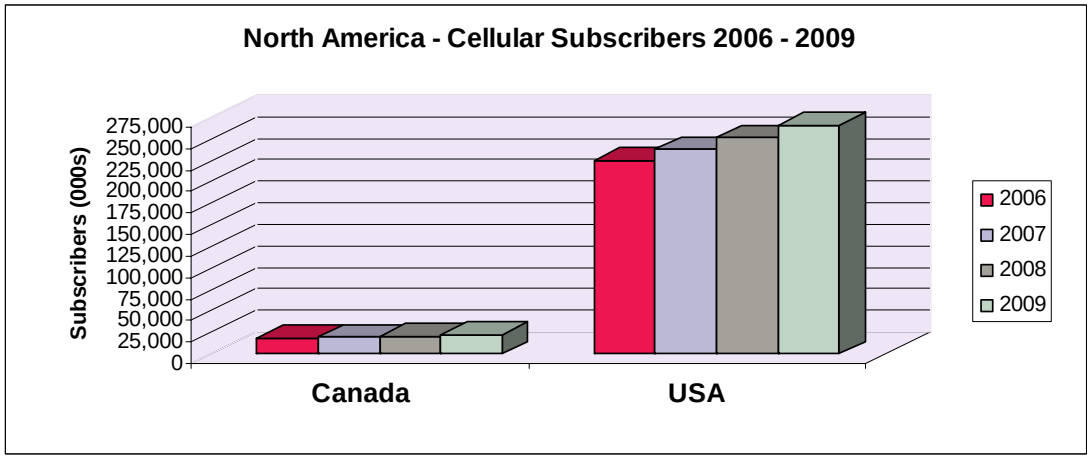

Figure 16 — North America Cellular Subscribers — Canada and US (Mexico included in Latin America)[47]

As penetration increases, we see a move towards: consolidation (both business consolidation increased through mergers and acquisitions, and network consolidation through convergence and evolution to IMS/MMD); segmentation to allow for better market differentiation, with a particular focus on the youth, enterprise and small to mid sized business segments; and a focus on data services. North America has seen

mergers, acquisitions and consolidation as a result of pressures from a shrinking addressable market, and increased competition due to the entry of MVNOs.

Latin America

Latin America (see Figures 17 and 18) offers both opportunities and challenges. Opportunities exist because of relatively low penetration rates to date; and challenges exist because of a large percentage of population has limited spending power. Brazil and Mexico together represent a large percentage of the entire cellular penetration in the region. By 2009, Latin America is expected to represent just over one tenth of the world's cellular subscriber base.[49] KAZAM believes that the subscriber ARPU in Latin America is anticipated to reach approximately US$16 by 2009, just ahead of China and India. Latin America also represents the world's highest prepaid subscriber base, growing to over 90 percent by 2009 according to KAZAM's projections. Prepaid customers usually spend less than post-paid, representing additional challenges for operators in this region. The outlook has a silver lining however, as KAZAM predicts that spending on data services are expected to grow over the next three years to approximately a quarter of all cellular revenues in the region. As a result, there is a potential for enhanced data services and for growth in revenues from high value customers.

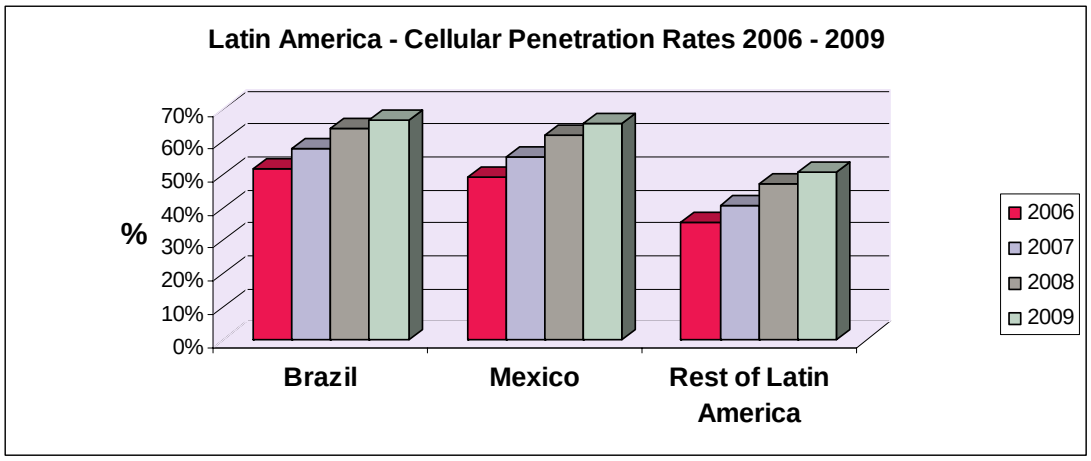

Figure 17 — Latin America Cellular Penetration Rates 2006–09[47]

[49] 3GSM World Congress Presentation (Barcelona, Spain), *3G Americas, Exploring Why GSM is the #1 Evolution Choice in Latin America*, February 2006.

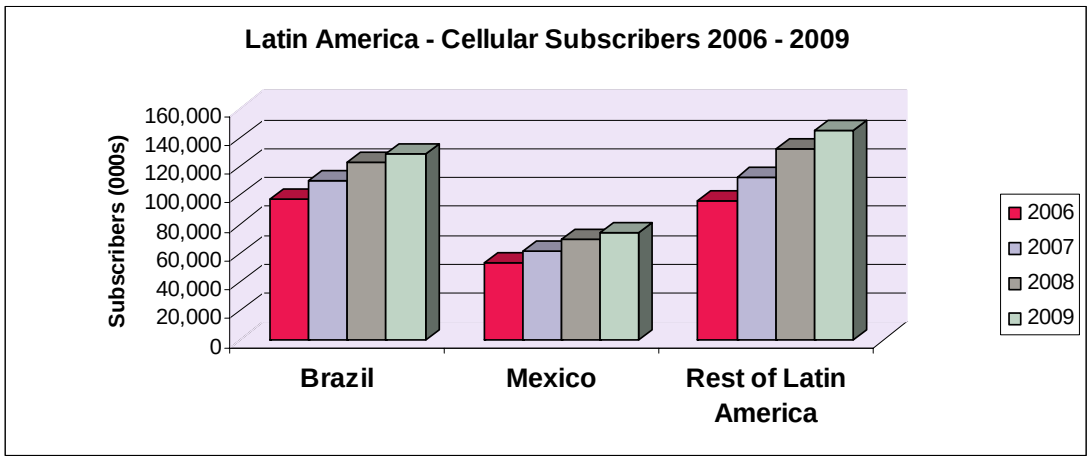

Figure 18 — Latin America Cellular Subscribers 2006–09[47]

Western Europe

Western Europe represents the highest penetration rates in the world, with several countries exceeding 100 percent (see Figure 19). This is partly due to people having multiple SIM cards, but mostly due to having a head start over North America as a result of a single pan-European standard for digital cellular (GSM) and aggressive uptake. Western Europe presents the weakest growth in subscribers anywhere in the world because of their already high penetration rates (see Figure 20). Most of the opportunities in this region will come from content, value-added services, and applications, as well as through roll-out of enhanced 3G capabilities such as HSDPA and HSUPA to support these services. KAZAM anticipates that between 2006 and 2009 growth in data revenues will outpace growth in voice revenues by a ratio of four to one. KAZAM expects the percentage of prepaid subscribers in this region to grow marginally to about 70 percent by 2009.

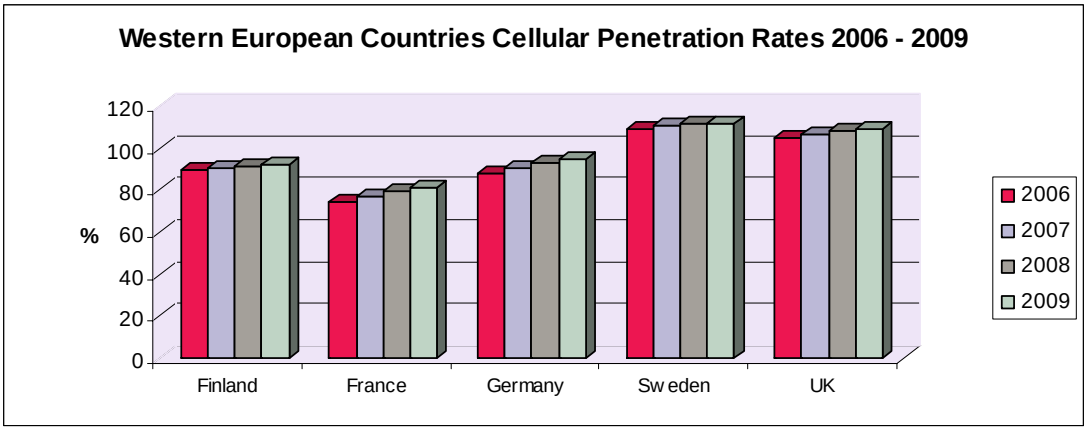

Figure 19 — Western European Countries Cellular Penetration Rates 2006–09[47]

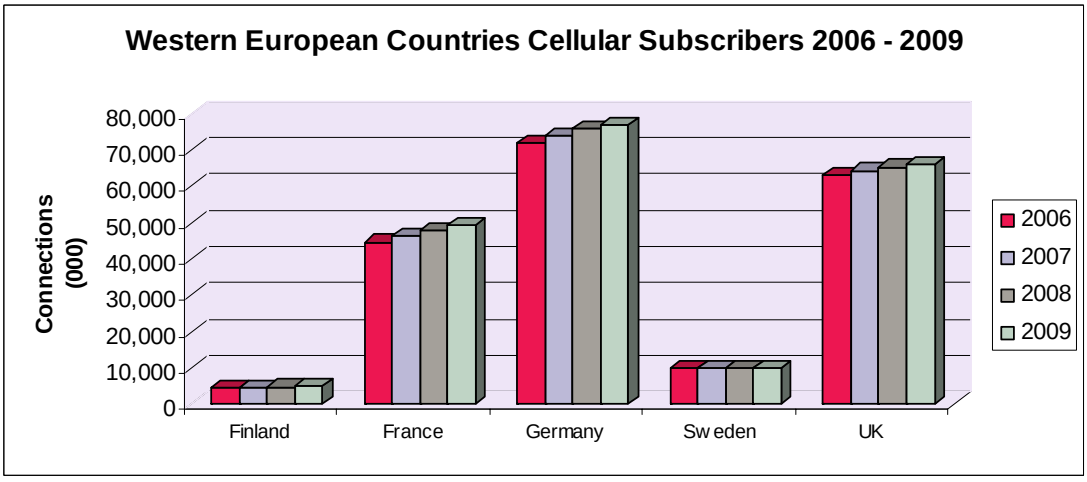

Figure 20 — Western European Countries Cellular Subscribers 2006–09[47]

Eastern Europe

Eastern Europe (see Figures 21 and 22) still offers opportunity for subscriber growth as well as for growth in revenues from mobile data. KAZAM believes that Eastern Europe will experience a CAGR of approximately 8 percent for cellular subscribers between 2006 and 2009. During this time, there will be a downward trend in ARPUs as international operators enter these markets to drive competition. Mobile data services are expected to pick up, and contribute as much as a quarter of cellular revenues for the Russia, Turkey and Ukraine markets over the next few years.[50] KAZAM anticipates that the percentage of prepaid subscribers in this region will exceed 90 percent by 2009.

[50] 3GSM World Congress Presentation by Pyramid Research (Barcelona, Spain), *CEE Mobile Powerhouses: Russia, Turkey, Ukraine Growth Opportunities*, February 2006.

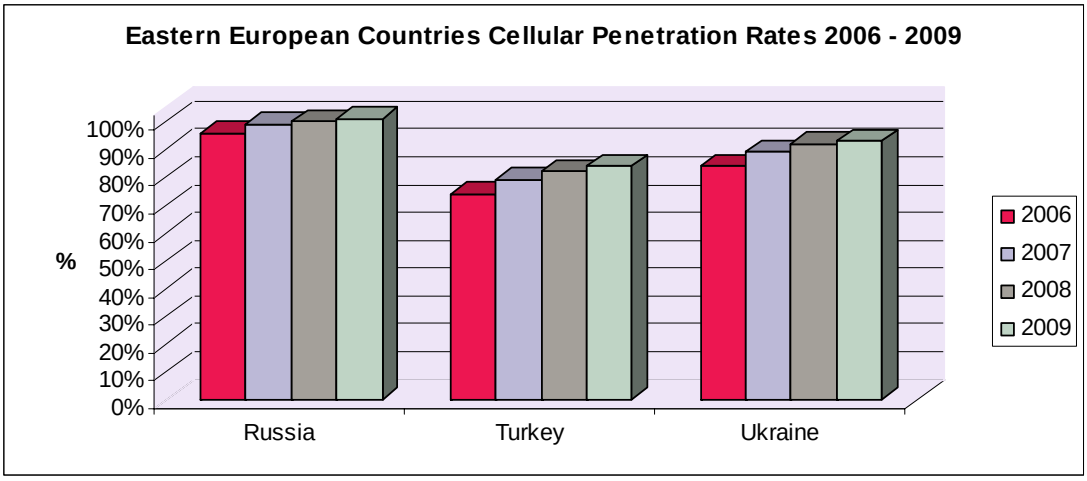

Figure 21 — Eastern European Countries Cellular Penetration Rates 2006–09[47]

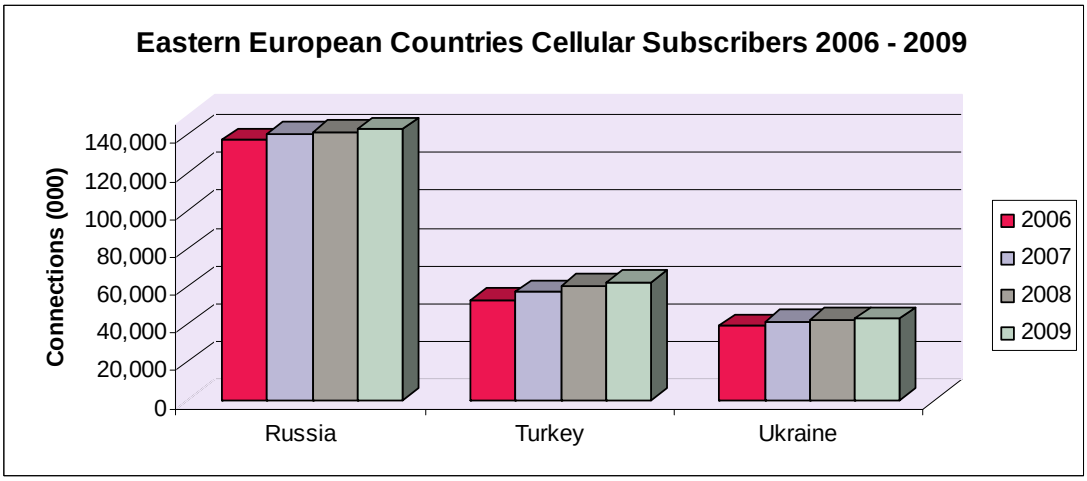

Figure 22 — Eastern European Countries Cellular Subscribers 2006–09[47]

Asia

The Asian market can really be divided into three main areas based on the maturity level of wireless and the size of the respective countries: South Korea and Japan; China and India; and the rest of Asia.

KAZAM believes that while penetration rates in South Korea and Japan are expected to grow nominally to the just over the 80 percent mark over the next three years, these countries represent the leading edge of technologies and services when it comes to cellular and many other wireless sub-sectors (see Figure 23). They are often first to launch new technology and services, thereby both leading in the development (often pre-standard) of new technology, and also in being early adopters of technology. KAZAM understands that revenues from content and data applications already represent close to 25 percent of the total revenues for most operators in these countries. We anticipate that the greatest opportunity for Canadian vendors in South Korea and Japan, beyond limited opportunities in leading edge technology, is to offer services, particularly in the area of customer care and loyalty and retention programs. In South Korea, customer care has not kept pace with their leadership in other areas of business.

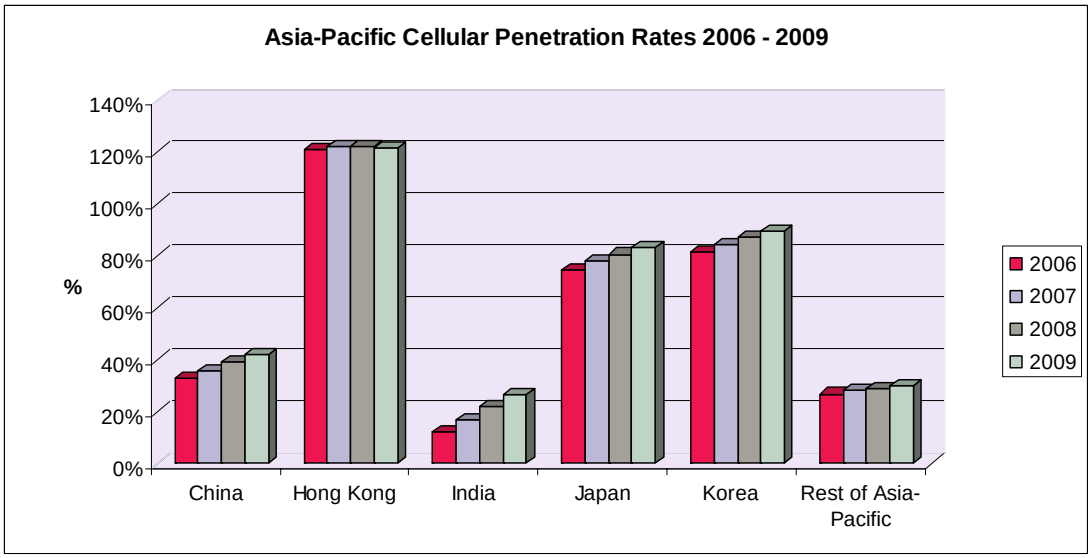

Figure 23 — Asia-Pacific Cellular Penetration Rates 2006-09[47]

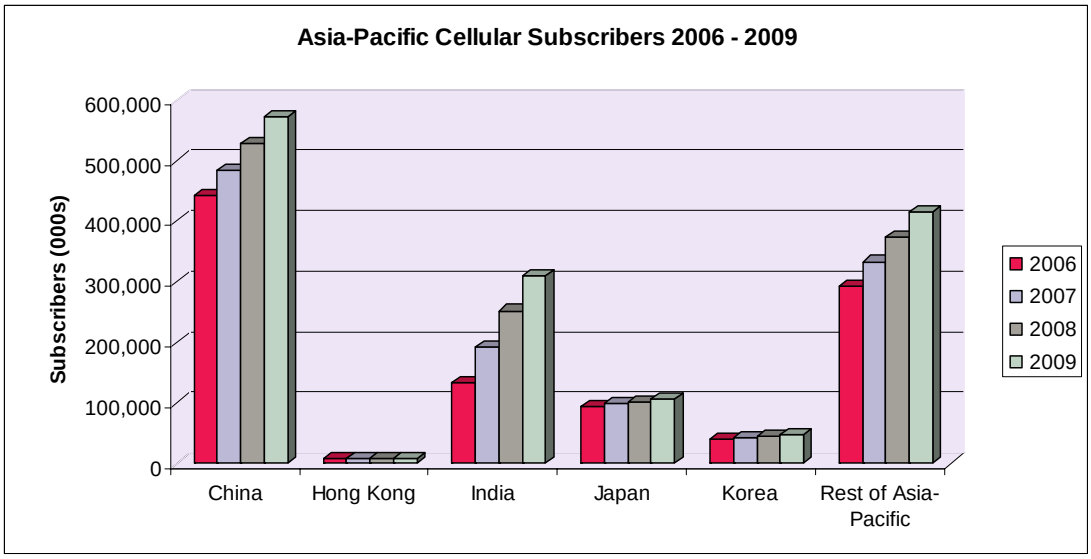

Figure 24 — Asia-Pacific Cellular Subscribers 2006 – 09[47]

With relatively low tele-densities and very large addressable markets, China and India represent one of the largest growing regions in the world for cellular subscribers, growing at a CAGR of approximately 9 percent and 30 percent respectively, between 2006 and 2009.[51] KAZAM believes that China and India together are anticipated to represent over a third of the world's subscribers by 2009 (see Figure 24).

India along with other emerging markets in Asia including Bangladesh, Pakistan, Indonesia, and the Philippines will be driven by the availability of low cost handsets. We anticipate declining revenues due to increased competition, improved network coverage (especially in India) and 'village phone'[52] initiatives in these markets. The GSM Association (GSMA) working in collaboration with operators from developing markets around the world, with the exception of China and Latin America, has formed the Emerging Market Handset Program (EMH) to offer ultra low cost handsets. It is important to note that while China did not participate in this program, Chinese vendors have undertaken their own low cost handset initiatives to serve the needs of their home market. The ultra low cost handset initiative has Motorola delivering handsets at sub $50 mark today, and this is anticipated to go down to sub $30 mark shortly.

[51] KAZAM Projections based on BDA Presentation — Growth Markets: China and India. 3GSM World Congress. Barcelona, Spain. February 2006.

[52] Village phone concept combines cellular services with public call office (PCO) concepts in villages, which enables villagers to use cellular services on an as-needed basis.

Middle East and Africa

KAZAM believes that the Middle East and Africa (MEA) regions will experience the highest CAGR of cellular subscribers in the world, at approximately 14 percent between 2006 and 2009 (see Figure 25). At this point, MEA will represent approximately 10 percent of the world's cellular subscribers. MEA offers long-term opportunities for subscriber growth and resulting network rollouts. While KAZAM believes that the region currently has ARPUs of US$26, ARPUs are expected to decline considerably by 2009, as emerging markets grow faster than developed markets. Another contributing factor to declining revenues is from deregulation and resulting competition in the market. The percentage of pre-paid subscribers is expected to be slightly behind Latin America by 2009. The region offers opportunities for network rollouts and expansion, enhanced 3G networks and data services in Israel and most Gulf States including the UAE and Bahrain. Professional services are also highly sought after in this region. While Israel has the highest penetration of subscribers, closely followed by the UAE, these countries also represent some of the smallest number of subscribers in the region (see Figure 26).

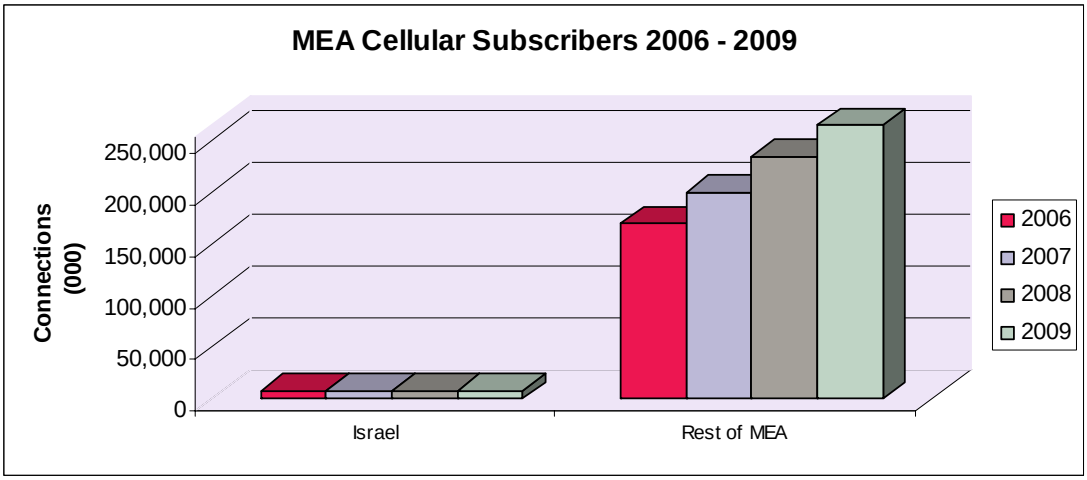

Figure 25 — Middle East Africa Cellular Subscribers 2006–09[47]

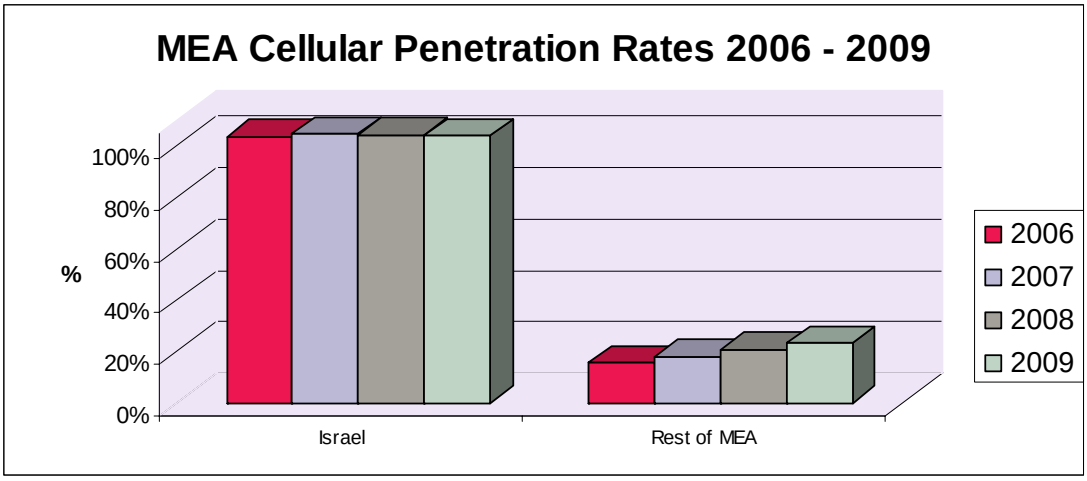

Figure 26 — Middle East Africa Cellular Penetration Rates 2006–09[47]

Cellular Infrastructure Spending

Growth in cellular infrastructure spending will come from two main areas: evolution to 3G and mobile data services for developed markets; and network rollouts in emerging markets.

In developed markets including Western Europe, North America and parts of Asia–Pacific, infrastructure spending growth (see Figures 27, 28 and 29) will predominantly be in 3G. Spending on WCDMA/HSDPA/EVDO/CDMA2000 will grow as operators expand the footprint of their 3G networks to deliver high-speed data services. It is important to note that operators in these regions enjoy higher ARPUs than emerging markets, which enables them to be at the forefront of spending on next generation cellular infrastructure.

Emerging markets such as Brazil, Russia, India and China (BRIC), as well as Latin America, Eastern Europe, MEA and parts of Asia–Pacific will also contribute to cellular infrastructure growth (see Figure 30). Most operators will still look at expanding their footprint and spend more on 2.5G technologies initially, however, spending on 3G will pick up over the next four years. Operators in emerging markets have experienced declining ARPUs as a result of increased competition. This is a key contributing factor to their cellular infrastructure spending patterns. Emerging markets such as China are also in the midst of developing Time Division Synchronous CDMA (TD-SCDMA) and creating opportunities for local equipment vendors including Huawei and ZTE to better position them globally versus international equipment vendors.

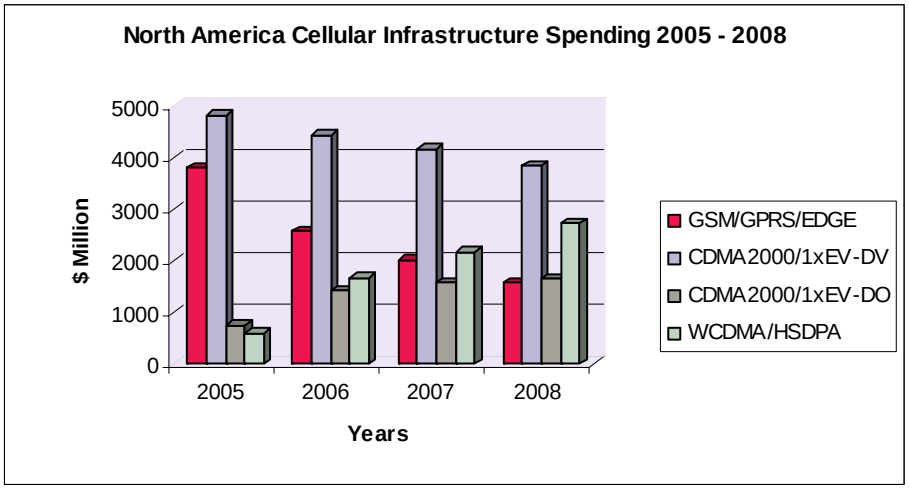

Figure 27 — North America Cellular Infrastructure Spending 2005–08[53]

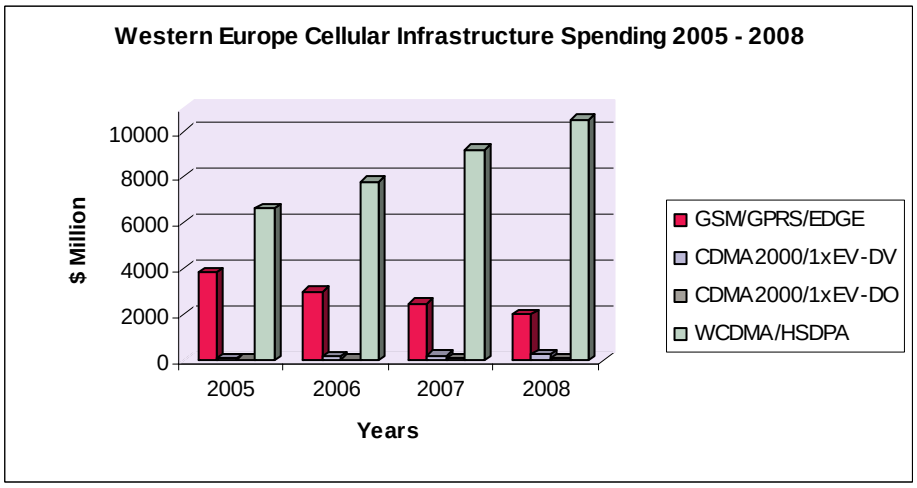

Figure 28 — Western Europe Cellular Infrastructure Spending 2005–08[53]

[53] Source: IDC, *IDC Worldwide Wireless and Mobile Network Infrastructure 2004–2008 Forecast and Analysis*, December 2004. Note that these forecasts exclude PDC/TDMA/iDEN and TD-SCDMA technologies.

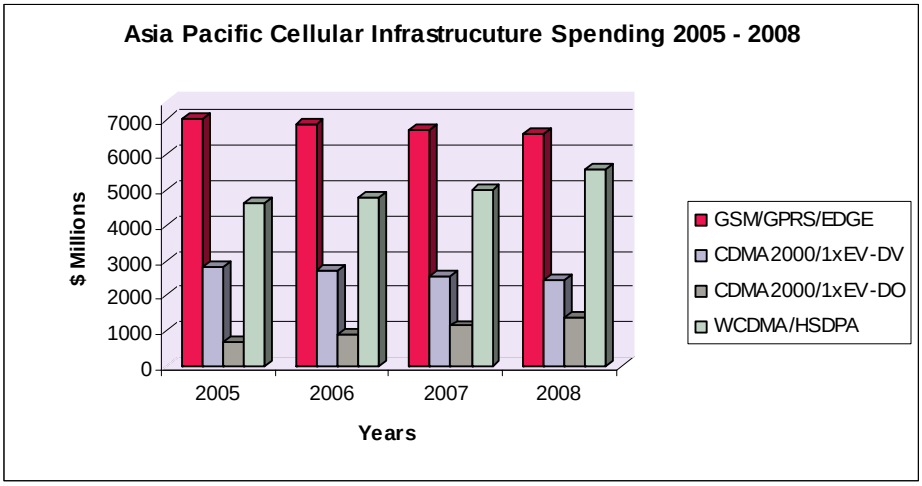

Figure 29 — Asia Pacific Cellular Infrastructure Spending 2005–08[53]

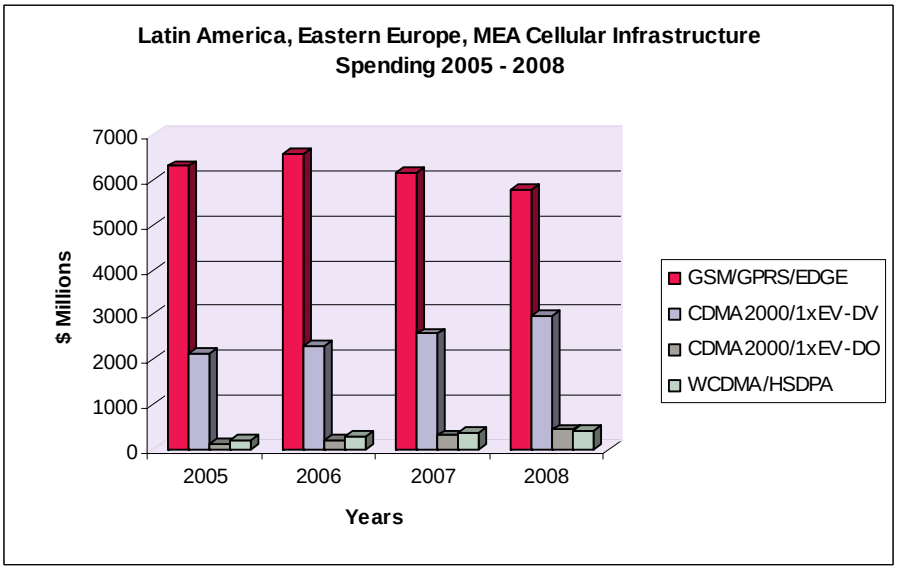

Figure 30 — Rest of World Cellular Infrastructure Spending 2005–08[53]

Global Handset Shipments

From our analysis of market reports and review of various sources including IDC, Gartner and Strategy Analytics, we find that there is a 10 to 12 percent variation in handset shipment estimates. KAZAM projections (see Table 1 and Figure 31) take into account the emergence of sub $50 and sub $30 handsets that will drive the handset market in emerging markets. As well, replacement sales of high tier 3G handsets and smartphones will drive the mobile handset market in developed and mature markets.

Global handset shipments exceeded more than 810 million units in 2005.[54] These figures are corroborated by other forecasts that estimate that global handset shipments for 2005 exceeded 810 million units worldwide.[55] KAZAM believes that growth will start tapering off 2008 onwards, after years of aggressive growth. The majority of growth in handset shipments will come from emerging BRIC countries, and markets in Latin America, MEA, Eastern Europe and Asia–Pacific. We believe that average handset prices will continue to drop as a result of the EMH to develop sub $30 handsets to service emerging markets and meet the needs of the next billion cellular subscribers.

KAZAM Forecasts	2006	2007	2008	2009
Handset Shipments (Millions)	920	995	1045	1076

Table 1 — Global Handset Shipments[56]

[54] Sources: Strategy Analytics Press Release, *Record 810 Million Mobile Phones Shipped Worldwide in 2005*, January 2006. http://www.strategyanalytics.net/default.aspx?mod=PressReleaseViewer&a0=2756. IDC Press Release: *A Strong Fourth Quarter Sends Worldwide Mobile Phone Shipments over 800 Million Units for 2005, According to IDC*, January 2006. http://www.idc.com/getdoc.jsp?containerId=prUS20056906.

[55] Gartner recently calculated worldwide mobile phone sales totaling 816.6 million units for 2005. Source: Gartner Press Release, *Gartner Says Top Six Vendors Drive Worldwide Mobile Phone Sales to 21 Percent Growth in 2005*, February 28, 2006.) http://www.gartner.com/press_releases/asset_145891_11.html.

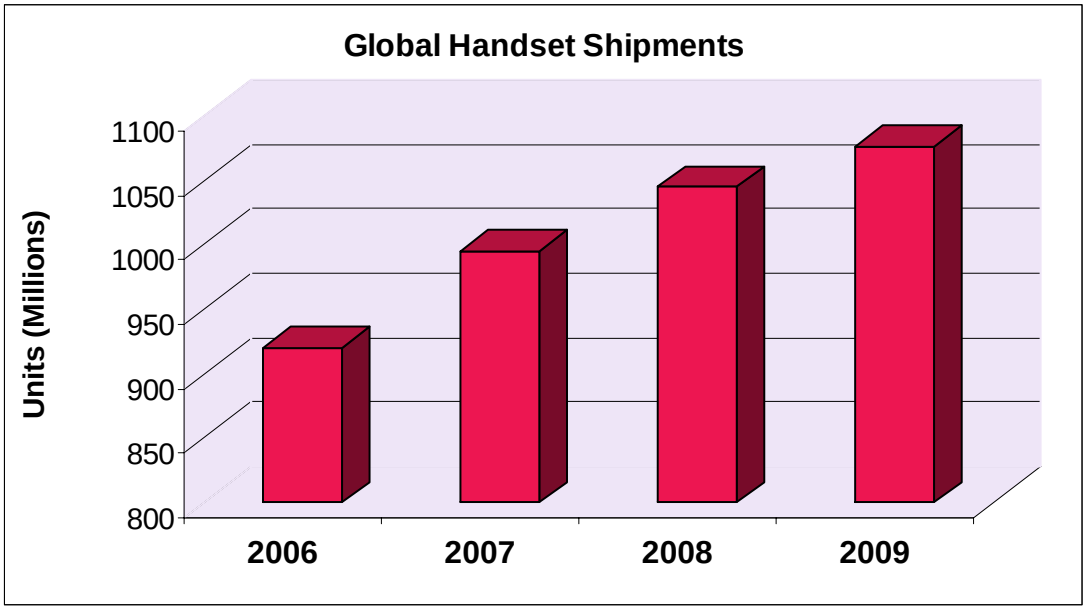

Figure 31 — Global Handset Shipments[56]

[56] KAZAM Handset Forecasts, 2006.

Mobile Data

For the purposes of this section, we have broken down mobile content into two main categories: Information Services, and Messaging and Entertainment Services. Information services include applications such as email, news, weather, etc. Messaging and entertainment services include messaging via SMS, MMS and instant messaging (IM), download of music, video, games, and streaming video and music, etc. For more information on mobile content and related services, refer to the section above titled *Evolution towards 3G — Key Services and Enablers.*

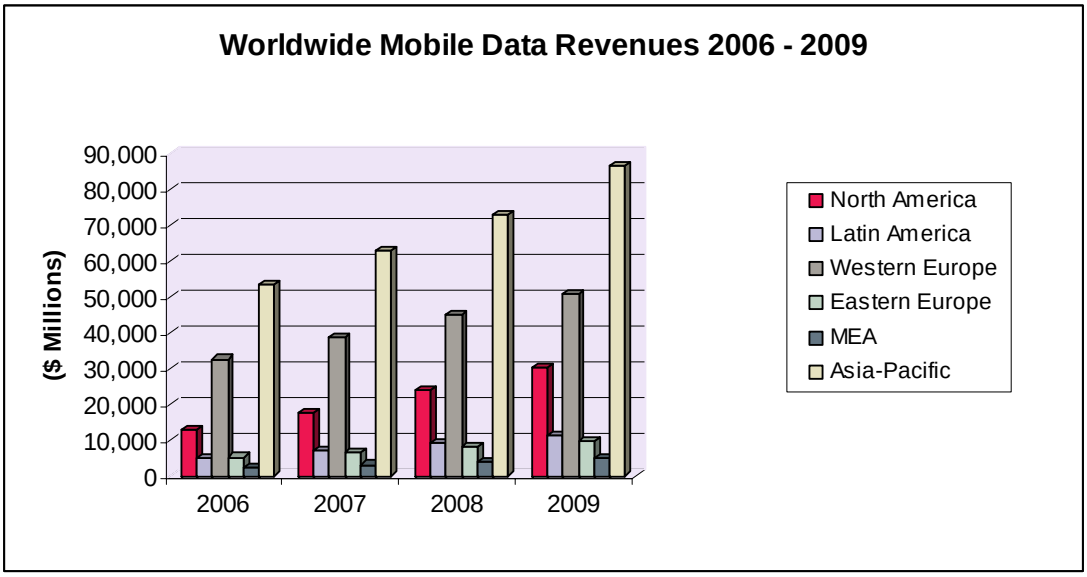

Figure 32 — Worldwide Mobile Data Revenues by Region 2006–09[57]

[57] KAZAM Mobile Data Forecasts, 2006.

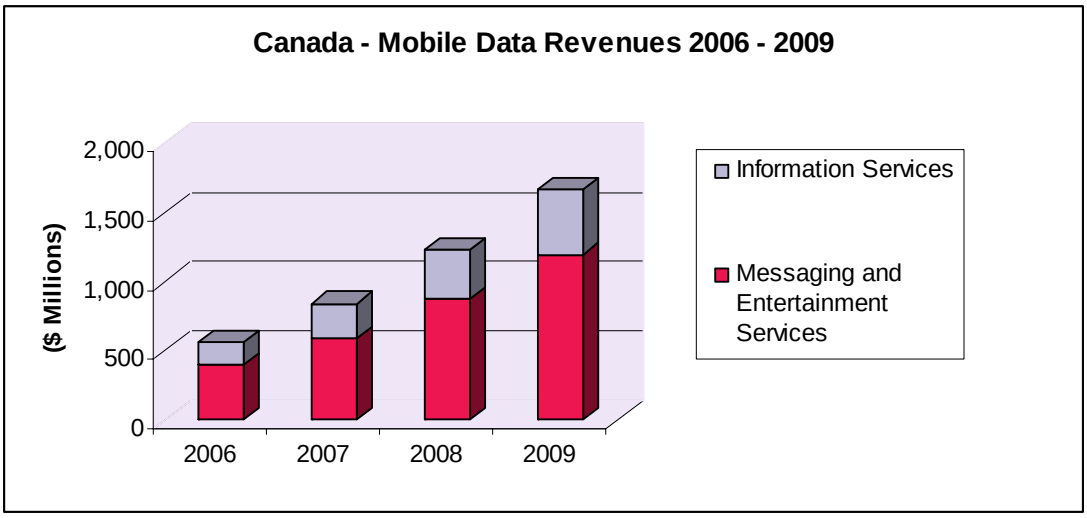

Figure 33 — Canada Mobile Data Revenues 2006-09[57]

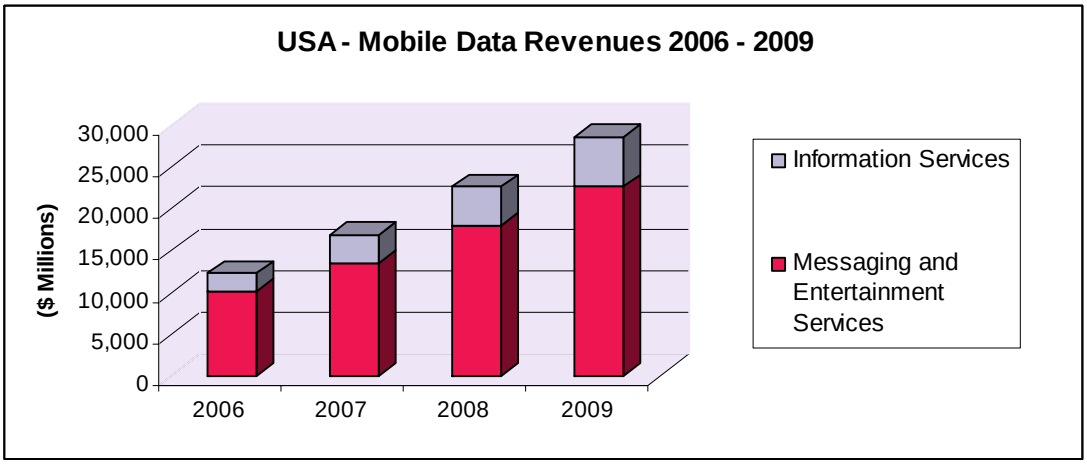

Figure 34 — US Mobile Data Revenues 2006-09[57]

Mobile data service revenues are expected to grow steadily over the next few years, as cellular networks evolve, offering users improved capabilities for higher throughput data services. Messaging still forms the bulk of mobile data revenues in North America and will continue to do so for the next four years, with a gradual trend from SMS to premium SMS and growth in MMS and Instant Messaging outgrowing basic text messaging. We believe that the North American mobile data revenues are expected to reach US$30B by 2009, fueled primarily by the US, which has a subscriber base that is twelve times that of Canada. Information and entertainment services will increase their share of mobile data revenues over the coming years as new services are launched (see

Figures 33 and 34). Mobile TV usage is expected to grow in North America, as MPEG4 capable handsets are seeded into the market.

Latin America

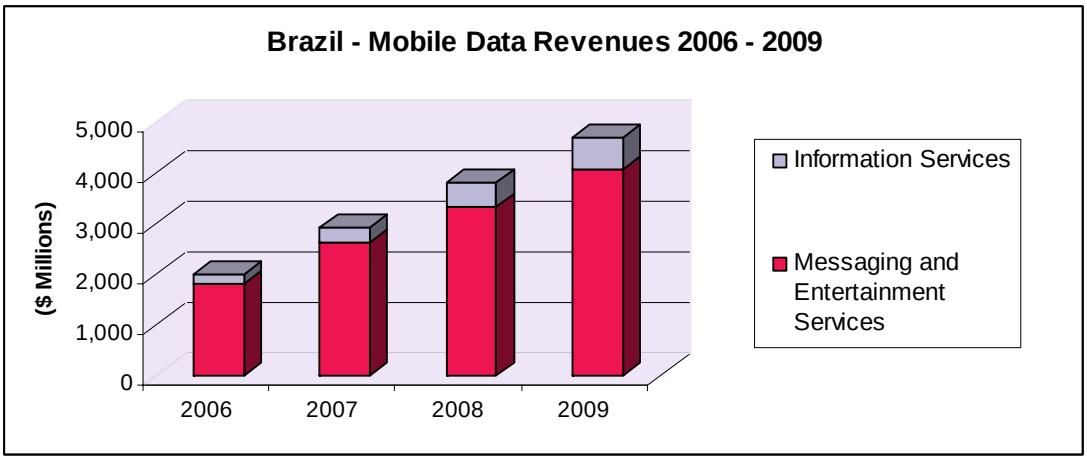

Figure 35 — Brazil Mobile Data Revenues 2006-09[57]

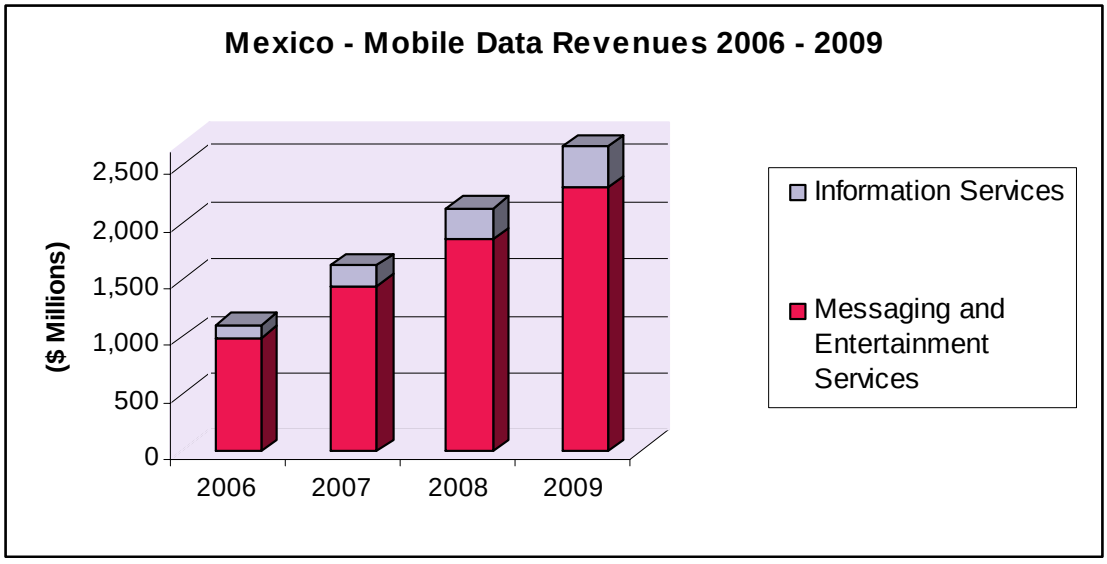

Figure 36 — Mexico Mobile Data Revenues 2006-09[57]

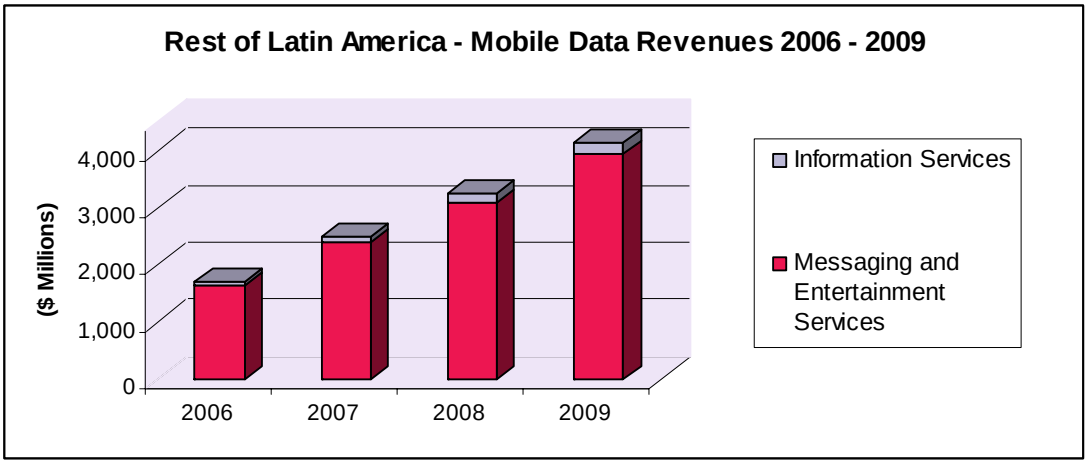

Figure 37 — Rest of Latin America Mobile Data Revenues 2006-09[57]

The Brazilian cellular market is similar to the Mexican market as both countries have roughly equal penetration rates (see Figures 35 and 36). As is the case with other emerging markets, messaging revenues form a large majority of mobile content services. Revenues from information services are quite low but expected to pick up rapidly over the next three years as high speed data networks are rolled out and take rates for information services improve.

Europe

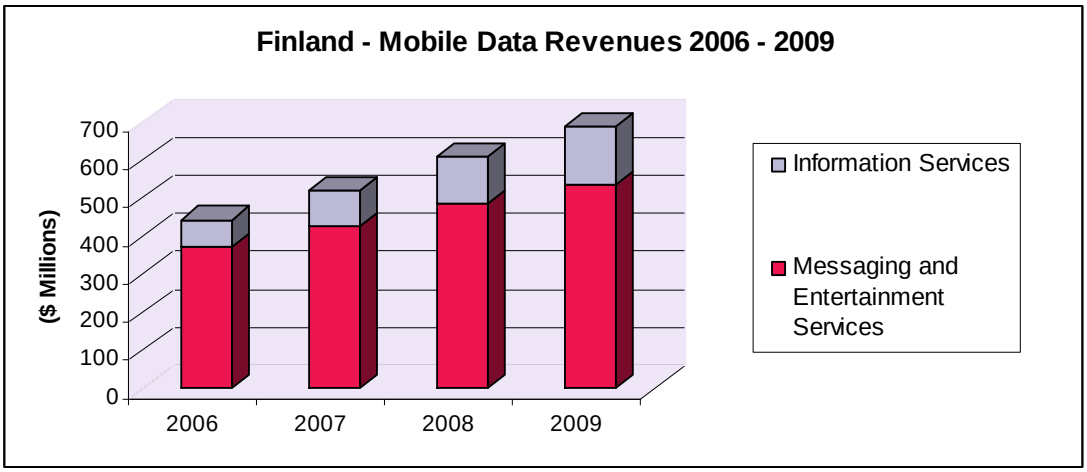

Figure 38 — Finland Mobile Data Revenues 2006-09[57]

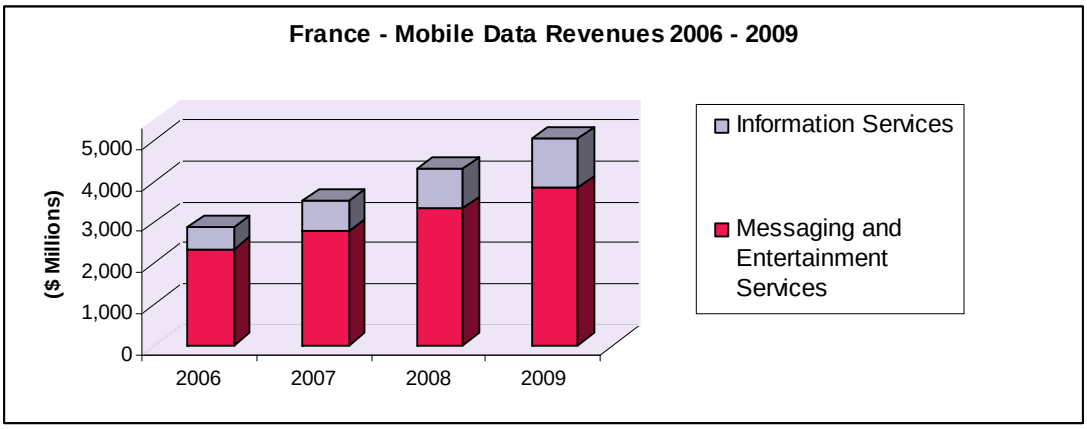

Figure 39 — France Mobile Data Revenues 2006-09[57]

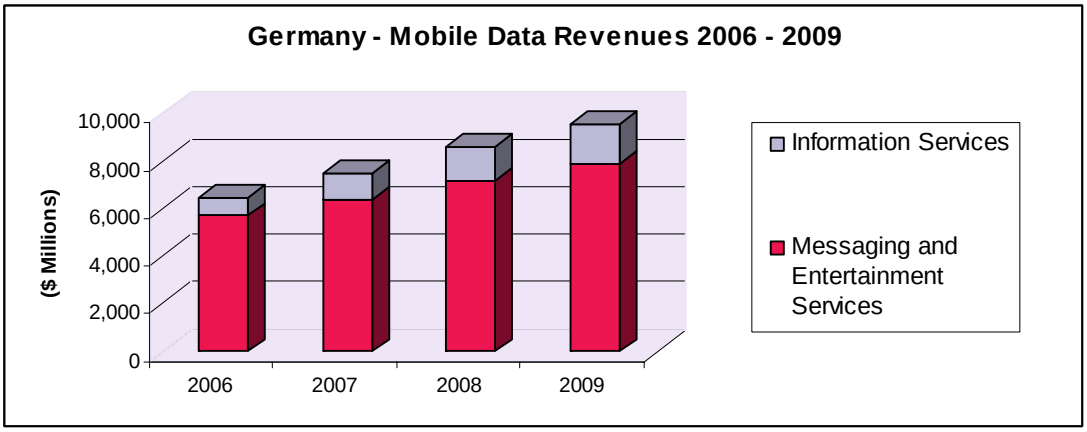

Figure 40 — Germany Mobile Data Revenues 2006-09 [57]

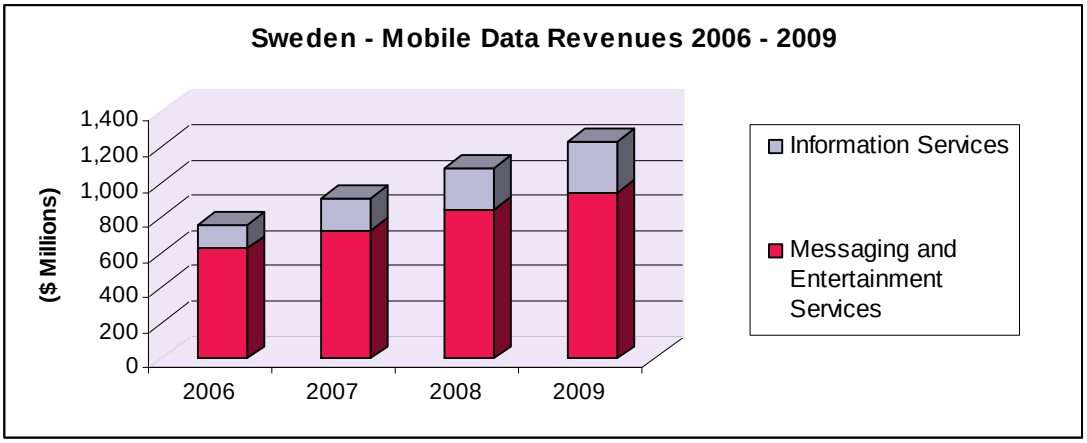

Figure 41 — Sweden Mobile Data Revenues 2006 - 09 [57]

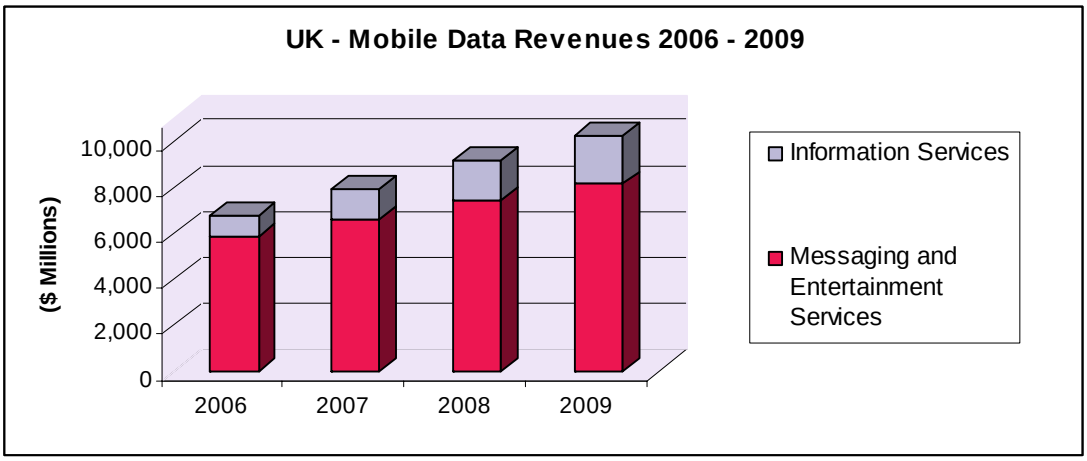

Figure 42 — UK Mobile Data Revenues 2006-09[57]

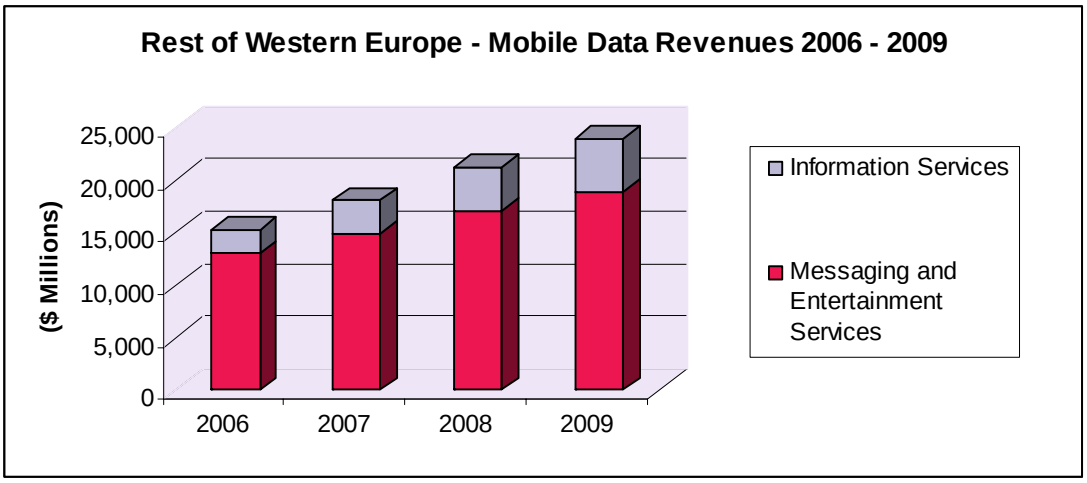

Figure 43 — Rest of Western Europe 2006-09[57]

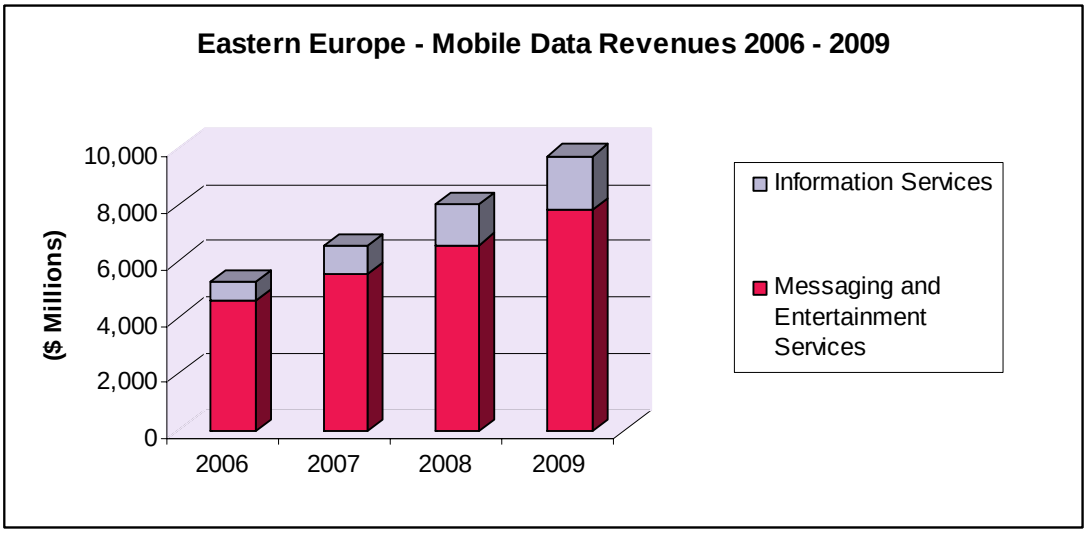

Figure 44 — Eastern Europe Mobile Data Revenues 2006-09[57]

UK, France, Germany, Finland and Sweden represent fairly developed cellular markets for mobile data services, as compared to Canada. The UK and Sweden enjoy over 100 percent mobile penetration rates. Messaging services still have a significant revenue share of the mobile data revenues in all six of the aforementioned European countries. Information and entertainment service revenues have a much larger share of the mobile data market in Europe than they do in Latin America, as a result of higher penetration rates, 3G services, handsets and better economic conditions (see Figures 38 to 44). In December 2005, Telephia,[58] a research firm providing performance data, published a study, which found that 3G was accelerating the adoption and use of mobile data services. The study found that 3G users:

- generated higher data ARPU, US$75/month for 3G users vs. US$51/month for non-3G users;
- browsed the Internet more frequently than non-3G users 56 percent vs. 39 percent;
- downloaded content such as ring tones and games more frequently; and
- used bandwidth intensive applications such as streaming TV more often than non-3G users 10 percent vs. 1 percent.[58]

Middle East and Africa

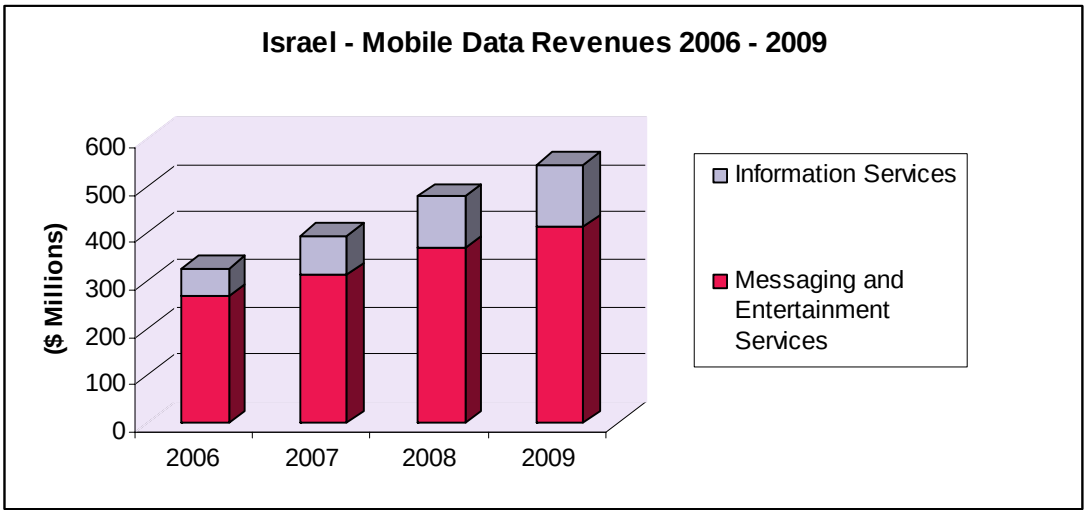

Figure 45 — Israel Mobile Data Revenues 2006-09[57]

[58] Source: Telephia, *Mobile Data Services Adoption and Spending in the UK increases with 3G, According to Telephia,* http://www.telephia.com/documents/3GFINAL12.12.05.pdf.

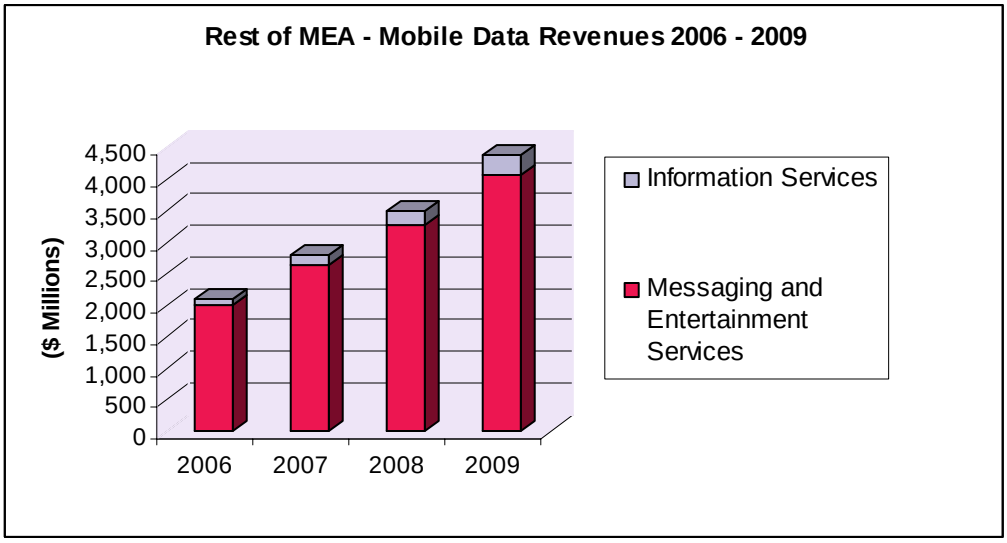

Figure 46 — Rest of MEA Mobile Data Revenues 2006-09[57]

The summary of the MEA region (see Figures 45 and 46) showcases that Israel represents approximately 14 percent of the market share for mobile data services in MEA. Israel is one of the few developed markets in the MEA region and has high information service revenues compared to messaging revenues. Messaging is still the strongest mobile data service, but will lose revenue share to information and entertainment services over the next few years. The MEA region includes a lot of developing countries with poor mobile penetration rates at this time. As these countries' wireless penetration and services mature, Israel's relative market share of the MEA mobile data market will decline steadily.

Asia

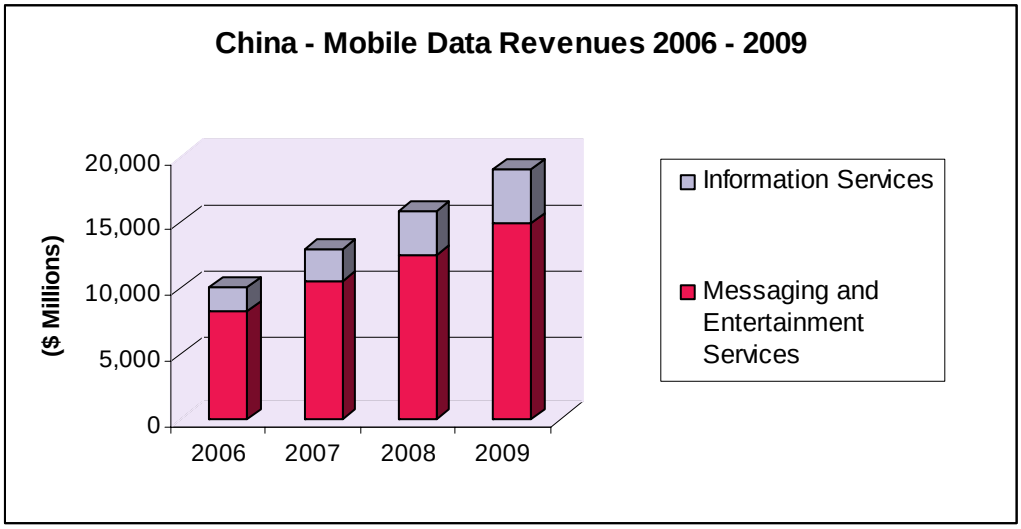

Figure 47 — China Mobile Data Revenues 2006-09[57]

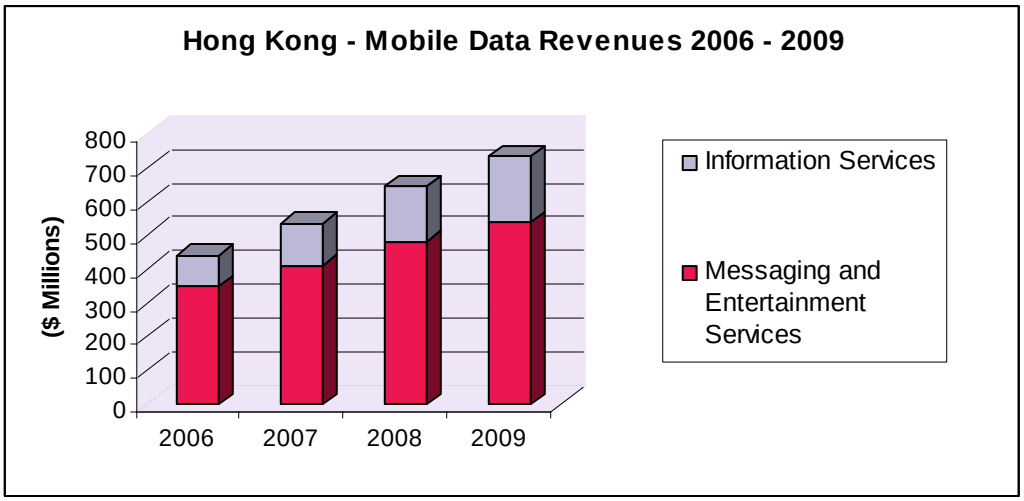

Figure 48 — Hong Kong Mobile Data Revenues 2006-09[57]

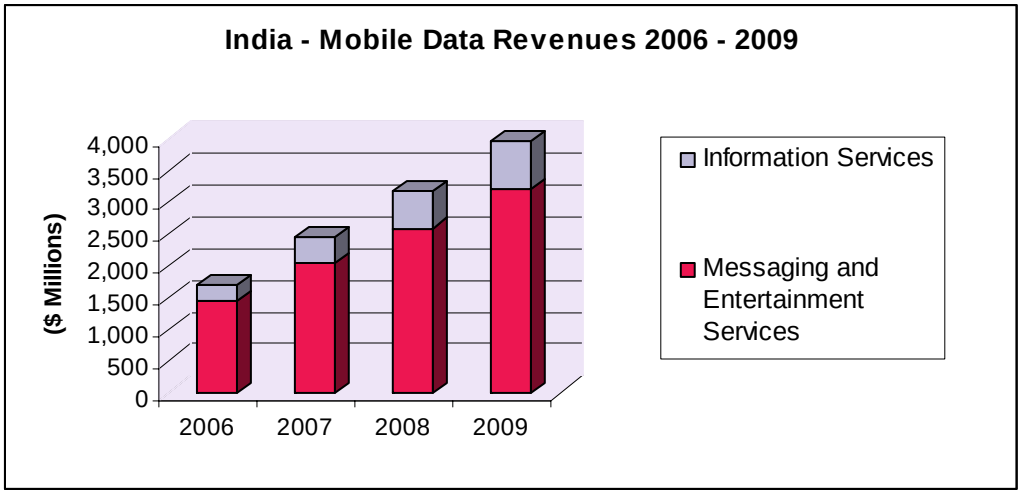

Figure 49 — Hong Kong Cellular Data 2006-09[57]

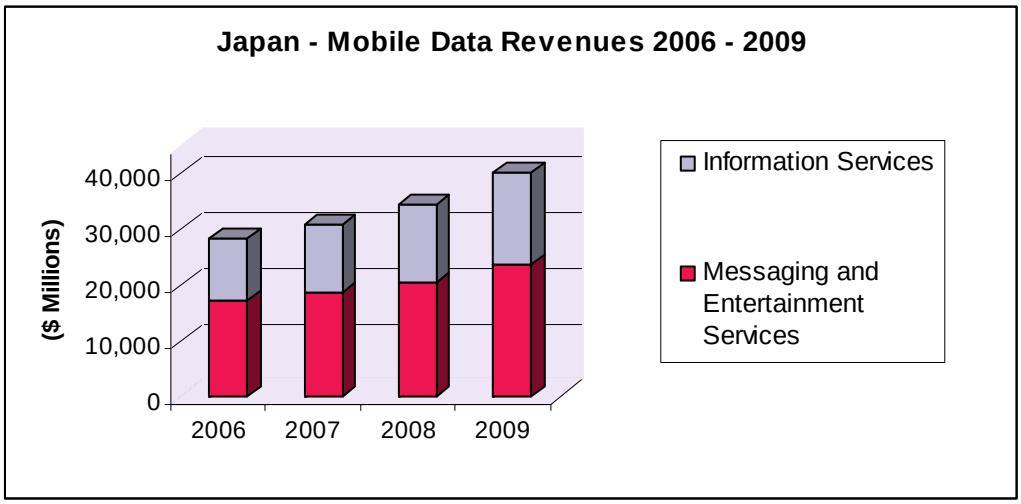

Figure 50 — Japan Mobile Data Revenues 2006-09[57]

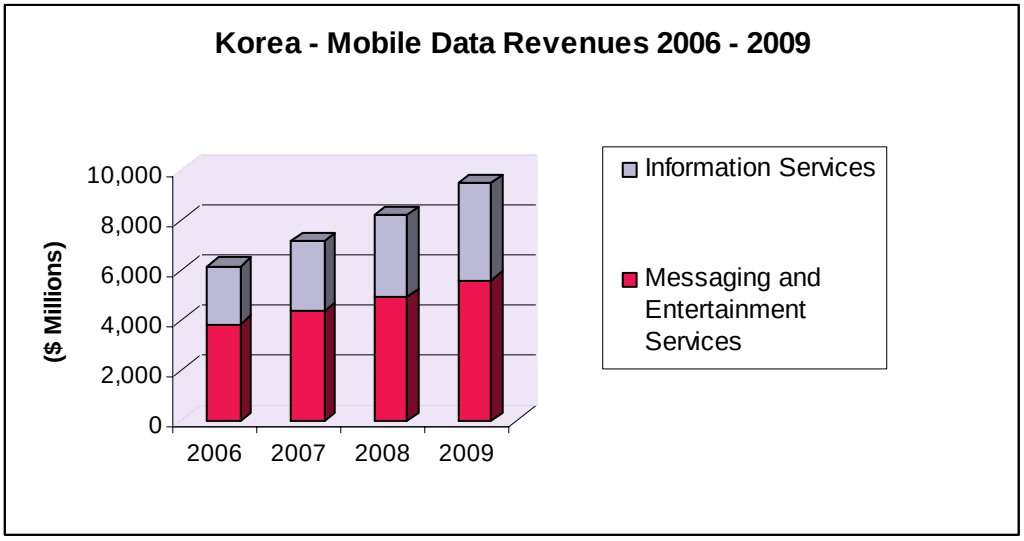

Figure 51 — South Korea Mobile Data Revenues 2006-09[57]

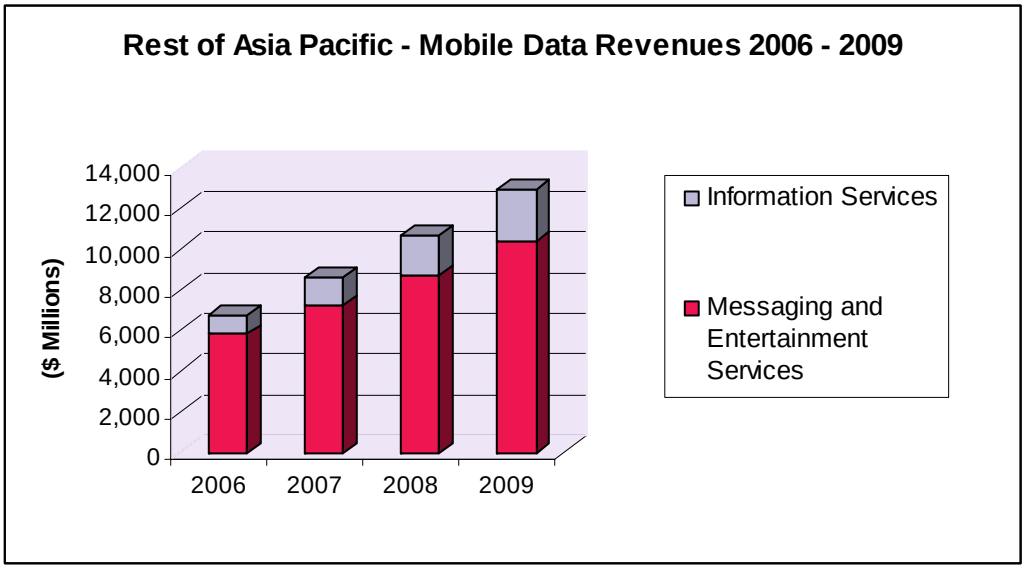

Figure 52 — Rest of Asia–Pacific Mobile Data Revenues 2006-09[57]

The four countries presented above, China (see Figure 47), Hong Kong (see Figure 48), India (see Figure 49), Japan (see Figure 50), South Korea (see Figure 51) and the Asia–Pacific region (see Figure 52) represent an interesting mix of cellular markets. Japan, South Korea and Hong Kong are mature and advanced markets with Hong Kong's penetration rate reaching well over 100 percent by the end of 2006. South Korea is around 80 percent penetration and Japan has approximately 75 percent cellular penetration. We see a difference in mobile data revenue breakdown for these three markets.

In Japan and South Korea, information and entertainment service revenues far exceed messaging revenues. This is partly because 3G networks, including W-CDMA and EV-DO were launched several years before anywhere else in the world. Japan's market leader NTT DoCoMo, has enjoyed tremendous success with its mobile data portal called i-mode. This has led to websites, content and applications being developed and targeted towards i-mode users. In addition to this, users use i-mode email instead of SMS as the latter is not as flexible and is more expensive than email. South Korea is another country where messaging revenues lag behind information and entertainment revenues as South Koreans are technologically trendy people and early adopters of new technology. SK Telecom, the leading operator of mobile services in South Korea, offers two branded portals called Nate and June, which offer users across six distinct segments, a variety of content and applications such as streaming video content, games, music, location, and m-commerce services.

India and China collectively represent the biggest market for cellular growth in the world. We believe that both have fairly low penetration rates and demonstrate mobile data revenue breakdown similar to that of countries in Latin America. Infotainment service revenues are expected to increase more rapidly than messaging revenues as market penetration increases and innovative infotainment services are introduced into the market. Despite being a smaller market, infotainment spending in Japan is expected to far exceed that of China and India collectively.

Radio Frequency Identification

Manufacturers and distributors have increasingly employed RFID professional services to tie together various components including RFID tags, readers, middleware and software. The demand for professional services is currently on the rise (see Figure 53).[59] KAZAM believes that the revenues from professional services in this sub-sector will actually surpass revenues from equipment sales by 2008. RFID is being driven mainly by large manufacturing and retail outlets like Wal-Mart that have pushed suppliers to comply with their request for RFID enabled products, creating a ripple effect among potential adopters.

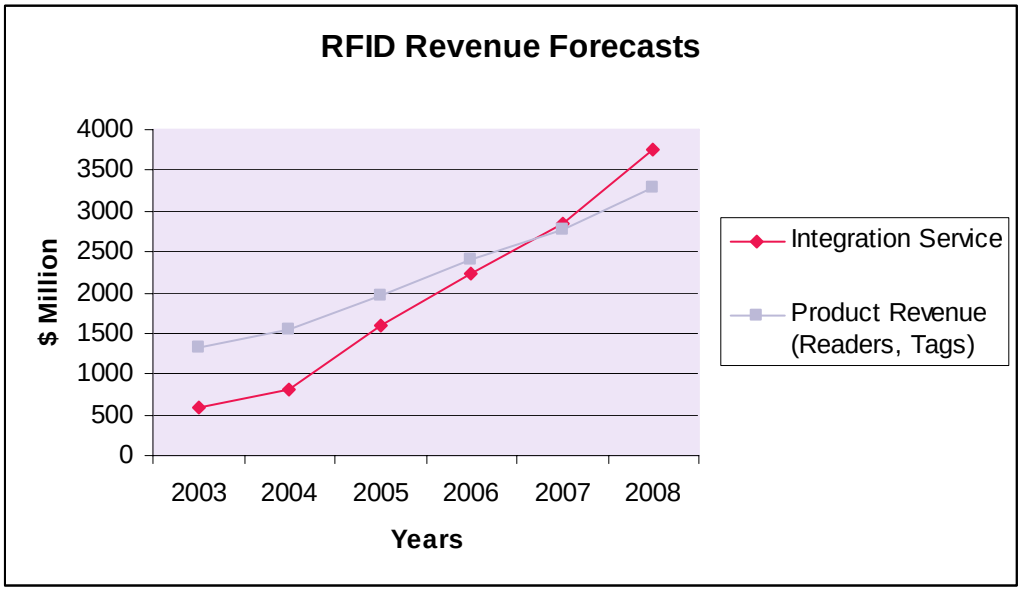

Figure 53 — RFID Revenue Forecast (Integration Service vs. Product Revenue)[60]

In-Stat predicts that revenues in the global RFID tags market will grow from $300 million in 2004 to $2.8B by 2009 (see Figure 56).[61] The growth will primarily be fueled by the manufacturing and logistics industry and adoption will be driven by lower RFID tag prices.

[59] Source: Lehman Brothers, RFID Today, March 2005.

[60] Source: Lehman Brothers, RFID Today, March 2005. Forecasts by ABI Research.

[61] Source: In- Stat Market Alert, *RFID Tag Market to Approach $3 billion in 2009*, http://www.instat.com/newmk.asp?ID=1206.

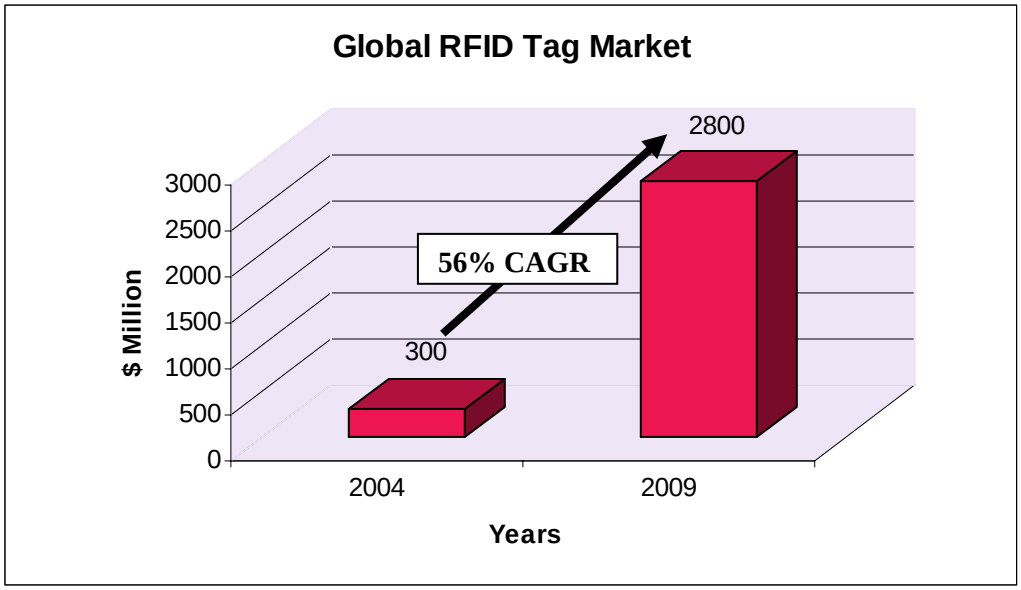

Figure 54 — Global RFID Tag Market [62]

It is anticipated that most of the global RFID spending will occur in North America and Western Europe (see Figures 55 and 56). RFID spending in Europe is expected to grow from US$464M in 2004 to US$1.9B in 2009, representing a 30 percent CAGR.[63] Broken down by verticals, the pharmaceutical industry is anticipated to represent US$408M; the mass transportation about US$371M; and retail US$315M. Most noticeable spending in Europe will be seen by UK and Germany, which currently represent about 40 percent of the total RFID market spending.[63]

[62] Source: In-Stat Market Alert: *RFID Tag Market to Approach $3 billion in 2009*, http://www.instat.com/newmk.asp?ID=1206.

[63] Source: Lehman Brothers, RFID Today, March 2005. Forecasts by Juniper Research.

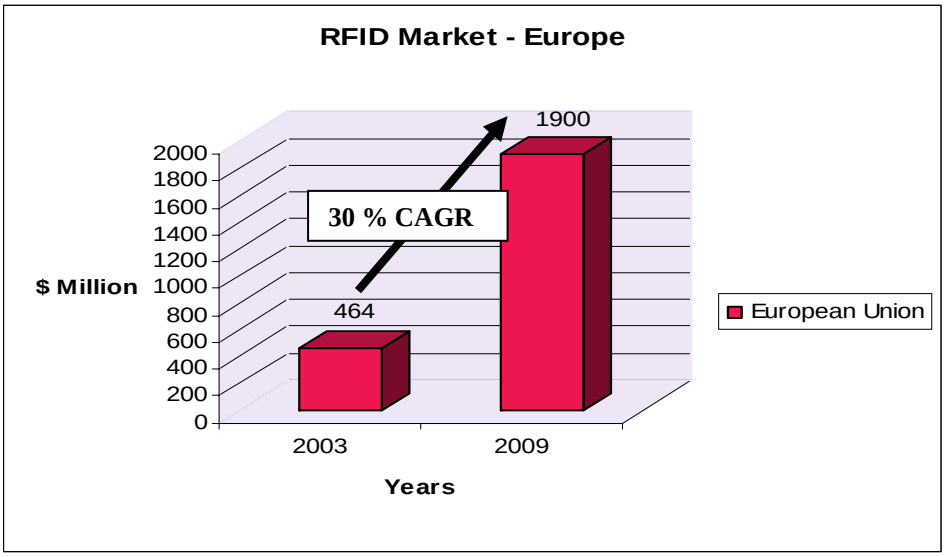

Figure 55 — RFID Market — European Union[63]

It is expected that RFID spending by the US Government is set to increase by 120 percent from US$51M in 2004 to US$112M in 2009, representing a 17 percent CAGR.[64] The US Retail sector's spending on RFID Systems is projected to exceed $1B by 2007 up from $91.5M in 2003.[65]

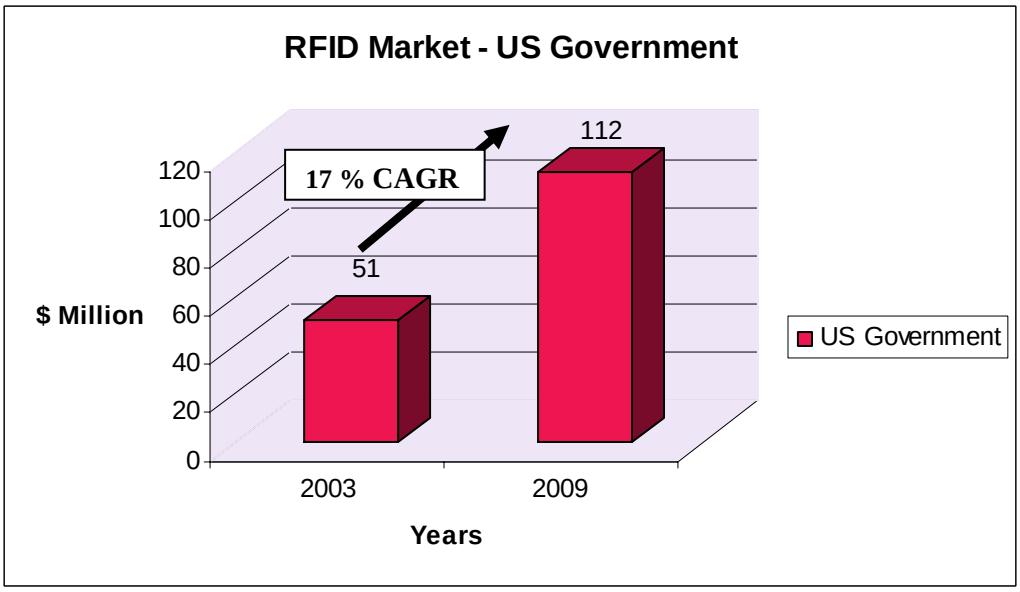

Figure 56 — RFID Market — US Government[64]

[64] Source: Lehman Brothers, RFID Today, March 2005. Forecasts by INPUT.

[65] Source: IDC: *US RFID for the Retail Supply Chain Spending Forecast and Analysis, 2003-2008*, Dec 2003.

WiMAX (802.16)

The emergence of IEEE 802.16 "WiMAX" standard (for Worldwide Interoperability Microwave Access), has stimulated widespread curiosity from not only traditional but non-traditional service providers interested in wireless broadband as an alternative access technology. WiMAX has the ability to compete with DSL and cable-modem services hence it will have a significant impact on the telecom industry. The number of WiMAX connections is forecast to reach 48 million worldwide by 2010.[66] These figures represent an optimistic outlook for WiMAX as the market is still in its early stages of development. A more conservative view of WiMAX shows a growth of only 3 percent of the total broadband subscribers, or 8.5 million subscribers worldwide adopting a WiMAX-based broadband wireless access service, by 2009.[67] KAZAM believes that key issues such as standard ratification and certification of WiMAX related products, as well as reduction in CPE costs, will play a fundamental role in growth of the technology. The initial hype including claims of performance hasn't helped WiMAX, and KAZAM feels that the more conservative numbers are likely realistic in the nearer term (next 24 months), with growth picking up as mobility comes into play, CPE costs come down, and interoperability is achieved.

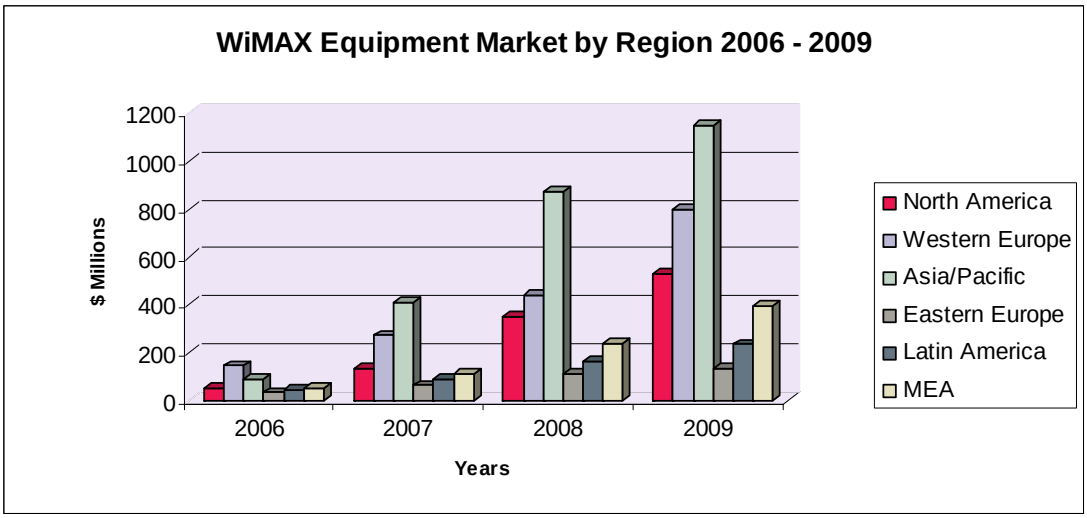

Figure 57 — WiMAX Equipment Market by Region 2006–09[68]

[66] Source: Gartner Report Summary, *Market Forecasts: WiMAX Worldwide 2005-2010* by Ian Keene, Jouni Forsman and Bettina Tratz-Ryan, November 15, 2005.

[67] Source: In-Stat Press Release: *WiMAX Has the Potential to transform Telecom Mmarkets*, February 2005 http://www.instat.com/press.asp?ID=1248&sku=IN0501958CT.

[68] KAZAM WiMAX Forecasts, 2006.

WiFi (802.11)

The use of WiFi continues to grow. This may be due to the following trends:

- increase in bandwidth, for example the evolution to 802.11n, which will support raw data rates of up to 540 Mbps representing a 10-fold increase over 802.11a and 802.11g; and
- evolution to Mesh Networks including roaming between WiMAX and traditional cellular networks.

Global WiFi revenues exceeded US$3B, with a 3 percent quarterly growth rate in 2005.[69] The Synergy Research Group estimates that this figure will double to more than US$6.14B by 2009.[70]

KAZAM believes that as speed and the number WiFi hotspots become more prevalent, so will the need for WiFi Mesh Networks. Worldwide WiFi has grown rapidly with close to 125 000 public hotspots in 2005. Market estimates project the number of public hotspots to grow to 308 000 by the end of 2009.[71] The rapid growth of hotspots and convergence between WiFi and other networks will bring about a multitude of new applications and services such as video, audio, data and voice (VoWLAN).

According to In-Stat, wireless mesh network revenues are expected to grow from just $33.5M in 2004 to $974.3M in 2009.[72] This will occur as wireless MAN's and larger enterprise wide WiFi deployments become more common. Voice of WLAN will also drive the expansion of WiFi from dispersed hotspots to larger area Mesh Networks, especially in enterprises.

WiFi enabled laptops and PDA's continue to fuel the growth of embedded WLAN chips, with 90 percent of these devices expected to have WiFi capabilities by 2007[73]. Worldwide WLAN Chipset sales are expected to exceed over US$90M by 2007 (see Figure 58) .[74]

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[69] Source: In-Stat, *Networking Quarterlies- WLAN, In-Stat 2004 & 2005 Quarterly WiFi Revenue Figures:* http://www.instat.com/catalog/ncatalogue.asp?id=160#IN0501943WL.

[70] Source: WiFi Planet, *Look Back to Look Ahead at WLAN Sales*, February 2005. http://www.wi-fiplanet.com/news/article.php/3485791.

[71] Source: Pyramid Research, *Hotspot Growth…and Google's Role*, September, 2005 http://evans.blogware.com/blog/_archives/2005/9/23/1252219.html.

[72] Source: In-Stat Press Release: *Wireless Mesh Network Market Accelerates*: http://www.instat.com/press.asp?Sku=IN0502465WS&ID=1461.

[73] Source: Frost & Sullivan, *World Voice over Wireless LAN Markets*, October 2004.

[74] Source: In-Stat Press Release: *Popularity of WiFi Drove WLAN Chip Market in 2002*, Apr 2003 http://www.instat.com/press.asp?ID=596&sku=IN030923WT.

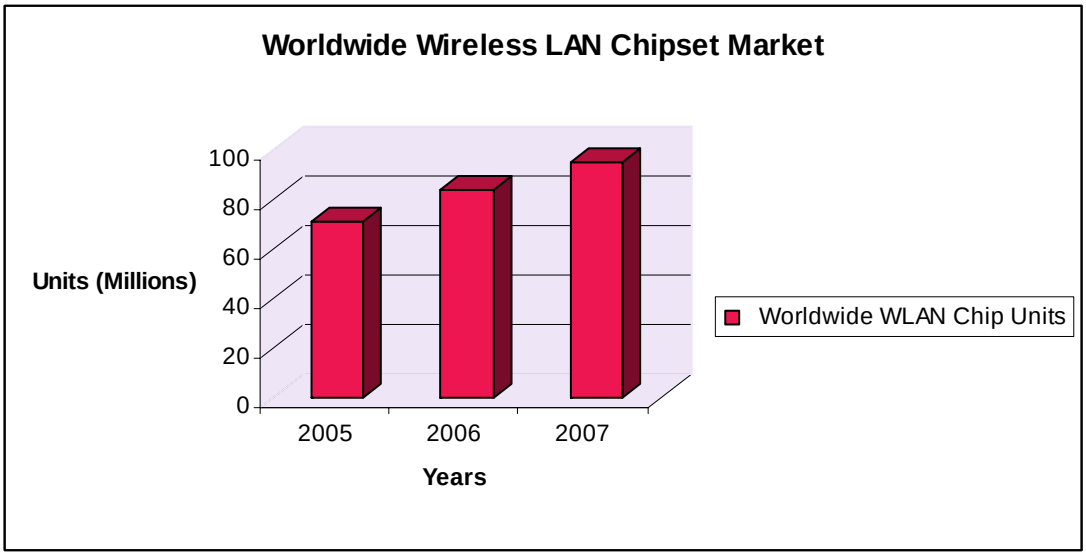

Figure 58 — Worldwide WLAN Chipset Market[75]

[75] Source: In-Stat Press Release: *Popularity of WiFi Drove WLAN Chip Market in 2002*, Apr 2003 http://www.instat.com/press.asp?ID=596&sku=IN030923WT.

Ultra Wideband

Ultra Wideband (UWB) operates at low power using spread spectrum technology and consumes little energy. In addition to its spectral efficiency and low power consumption, UWB is capable of very high data rates, anywhere from 100 Mbps up to 1 Gbps, over a few meters. UWB operates in what is known as a PAN, similar to interfaces such as Bluetooth and ZigBee.

In the last five years, several technological camps have been at loggerheads over the standardization of UWB. The multiple camps finally evolved into two sides that couldn't agree, each blocking the other from getting a formal IEEE standard approved. So the two sides have gone their separate ways, aiming initially at two different market approaches. The two approaches are not compatible. These groups are WiMedia Alliance with its version of UWB called multi band — orthogonal frequency division multiplexing (MB-OFDM), and UWB Forum, with its version of UWB called DS-UWB (direct sequence). Both use different radio techniques within spread-spectrum communications to communicate. Some of the big names in the WiMedia Alliance include Intel, Microsoft, Nokia and Philips, whereas the UWB Forum includes Motorola's spin-off Freescale Semiconductor, Seagate and OnStar. There is also a growing list of several companies who support both forums including Samsung and Sony. It is expected that while the UWB Forum products will initially focus on consumer electronics, the WiMedia products will initially target the wireless USB market.

The WiMedia Alliance has just had its MB-OFDM standard ratified by the non-profit European-based ECMA International. The ECMA-368 standard specifies the MAC and PHY layers in the 3 to 10 GHz range, whereas the ECMA-369 standard describes the interaction between the MAC and PHY layers. This new standard has been approved in the US only, however, WiMedia expects this to be approved in other regions of the world. WiMedia Alliance announced plans to commence product certification beginning in second half of 2006.

Several UWB products were unveiled at the Consumer Electronic Show (CES) in January 2006 by both camps. Companies showing products at CES 2006 included Belkin (associated with the UWB Forum), which demonstrated a wireless USB hub, and Gefen (part of UWB Forum) showcased its Wireless Universal Serial Bus (USB) Extender. Staccato Communications (part of the WiMedia Alliance), demonstrated wireless USB products branded Ripcord at the same show.

The hurdles faced by UWB in standardization have caused delays in commercial productization, and as a result it faces new challenges from 802.11n. The 802.11n standard promises data rates above 100 Mbps and over longer distances than UWB, and it will be backward compatible with earlier WiFi products. UWB's advantage over 802.11n is it uses 50 times less power, making it more suitable for battery hungry devices.

With commercial products still in the works, it is too early to predict how successful UWB will be in any of its implementations. UWB's overall cost, performance, and integration will also play a role. Below is a market projection from In-Stat (see Figure 59). As part of their assumptions, they expected UWB products to be demonstrated in January 2004 at the CES and UWB standards to be ratified by 1H of 2005, however this has not happened. KAZAM believes that the market projections need to be shifted out by 18 months to account for the aforementioned challenges.

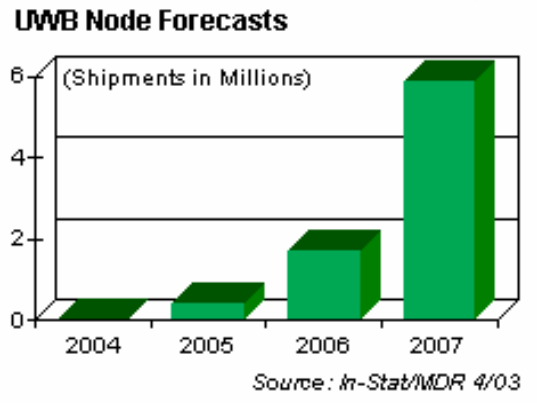

Figure 59 — UWB Node Forecast[76]

The widespread adoption of UWB-based products will depend on ease of use, affordability and interoperability. Growth in personal area communications, such as home theater systems, USB, 1394 (FireWire, used for connecting audio-visual devices), and the widespread use of consumer devices (game consoles, MP3 players, etc.) are driving the market for UWB. A number of existing technologies plan to adopt UWB radio platform, these include USB and IEEE 1394 (or FireWire).

Universal Serial Bus

USB currently has an installed base of more than one billion ports with an additional 2.5B interfaces forecasted to ship by 2006. While primarily PC-based now, the USB is branching out to address broader markets. The fast growing camera phone segment is quickly adopting USB to facilitate downloading of photographs. USB On- The-Go

[76] Source: In-Stat Press Release: *UWB Set to Make Commercial Debut*, May 2003: http://www.in-stat.com/press.asp?Sku=IN030727RC&ID=639.

(OTG) defines a dual role where the port can act as either a device or a host and thus operator in a quasi peer-to-peer mode.[77] (see Figure 60)

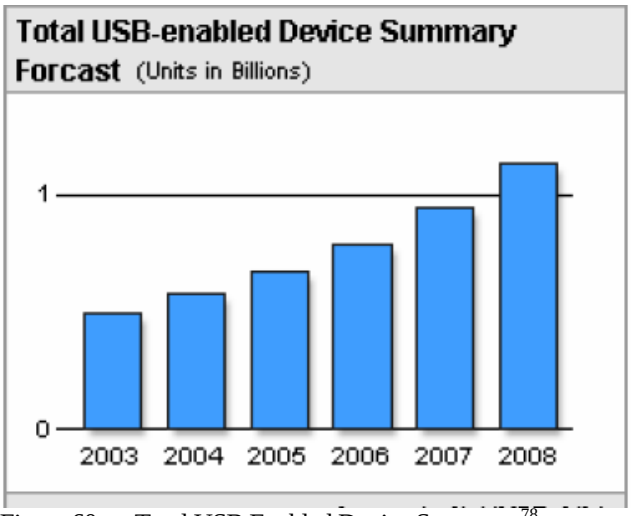

Figure 60 — Total USB Enabled Device Summary [78]

The Wireless USB (WUSB) promoters group, formed in February 2004, is charted with defining the WUSB specification using UWB radio, which will be backwards compatible with legacy wired USB interfaces.

IEEE 1394 (or FireWire)

More the 50 million devices were Firewire-enabled by 2003. Wireless 1394 will support up to 400 Mbps and the 1394 Trade Association approved a protocol adoption layer to bridge between applications developed for wired 1394 and the WPAN 802.15.3 (UWB). The current 1394-enabled product devices include Automotive, CE, PC, PC Peripherals (see Figure 61).[79]

[77] Source: Multiband OFDM Alliance, *Ultra Wideband: High-speed, short-range technology with far-reaching effects*, September 1, 2004.

[78] Source: In-Stat Press Release: *The Bus Rolls on for USB*: http://www.instat.com/press.asp?ID=903&sku=IN0401154MI.

[79] Source: Multiband OFDM Alliance, *Ultra Wideband: High-speed, short-range technology with far-reaching effects*, September 1, 2004.

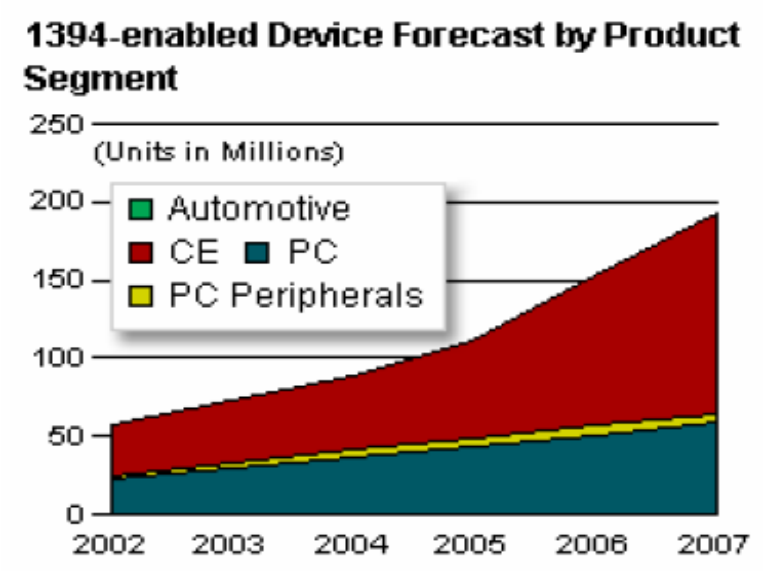

Figure 61 — FireWire Enabled Device Forecasts[80]

Bluetooth

Bluetooth has firmly established itself as a short-range wireless solution for voice and data transmission, and commercial shipments of products have been doubling year over year since 2002.[81]

Bluetooth-enabled mobile phones have dominated the market, with Bluetooth penetration into other products, including laptops, headsets, and portable music players on the rise. Bluetooth 2.0 + Enhanced Data Rate (EDR) chipsets hit the market in 2005, providing both greater bandwidth and lower power consumption. In May 2005, the Bluetooth Special Interest Group announced that UWB would become the foundation for an even higher data rate Bluetooth standard.

[80] Source: In-Stat/MDR May, 2003.

[81] Source: In-Stat, *Bluetooth 2005: The Future is Here*: http://www.instat.com/catalog/Ccatalogue.asp?id=216#IN0501837MI.

The Wireless Value Chain [82]

Technological leaps in wireless devices, networks, business models and applications have set the stage for wireless to transform itself from mobile voice to an all-pervasive, quickly implemented and integrated communication medium of choice. To capitalize and fully leverage opportunities, players must understand value propositions, the evolving value chain and the market structure of the various sides and contributors to the wireless industry. In this section, we look at the value chain in the wireless ecosystem, the factors that contribute to value, indicators of advantage and examples of value creation.

Developed economies are looking for "mobility," "reach-ability," "always-on," "anytime, anywhere" network access, and personalized, secure and cost effective services. Developing economies are looking for low cost, quickly implemented systems to meet basic needs. As well, some developing economies are looking at wireless technology to jump ahead into a new century, unrestricted by legacy wired infrastructure. Mobile wireless network operators have traditionally controlled and managed most of the value chain from network operation to front-end services, but this is changing.

In recent years, the value chain has become specialized into segments that include content related services and applications, network infrastructure, integration services, access devices, and a multitude of sub segments and niche applications. As the value chain has become more fragmented, we have seen the advent of Mobile Virtual Network Operators (MVNO) and other new business models that promise to transform the shape of wireless at rates not seen before, pushing wireless services closer to a strictly IP-based network. We are already beginning to see data services, telephony, business applications, media and entertainment all integrated into the same device.

Much of the wireless future has yet to be implemented, the success of which will likely be determined by how well the industry achieves interoperability among the different protocols and standards and maintains ever-increasing security standards. Markets are becoming more and more globalized and growth has slowed, suggesting consolidation, specialization and intense competition will be a key driver in the future of the industry. Under these conditions, creating value at every stage of the value chain becomes extremely important at both a company level and at a country level.

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[82] In developing the wireless value chain, KAZAM leveraged several sources of information including Dr. Michael Porter's model, which is more relevant to corporations. We extrapolated this with input from Industry Canada to develop the national value chain. We then leveraged our insights of the wireless industry to develop the wireless industry value chain. We acknowledge and appreciate the input and guidance provided by Mr. Ohannes Keuylian, Industry Canada as it relates to the development of the wireless industry value chain.

Analyzing the Wireless Value Chain

In the following section, we will describe the wireless value chain and the different components that make up that chain based on the widely accepted "Michael Porter Value Chain Model Framework"(see Figure 62)[83] We will examine the entire Wireless Sector Value Chain, identifying the key roles and functions. Our study will include identification of factors and indicators for each level of the value chain, which we will use in later chapters to evaluate the Canadian Wireless Sector against the United States and other leading markets for competitiveness and levels of export opportunity. The first part of our analysis will define the "Wireless Ecosystem" Value Chain, examining all of the inputs and factors at a national (macro) level. The second part will examine the "Wireless Industry" Value Chain, examining the micro level subsections of the sector.

Figure 62 — Michael Porter Value Chain Model Framework

Dr. Michael Porter provides us with a standard for discussing value chains that is widely accepted and studied. For our purposes, we have added one extra link to the chain: Market. Market forms a key factor in the wireless value chain and must be considered and studied equally with all of the other elements. Although Dr. Porter's model does not explicitly mention Market, it is implicitly present as the rest of the value chain would be meaningless without it. The point of the model is to split up the elements of an operation, or in our case a sector, to determine where there is competitive advantage or weakness. This will become especially valuable when we use this model to compare the wireless sectors in various countries and to compare countries for potential opportunity for Canadian wireless sector companies.

Dr. Porter's model also refers to the underlying factors of every link that includes R&D, human resources management, procurement and firm Infrastructure and governance. We will examine these as components of each link in the value chain.

As the wireless ecosystem has evolved, it has changed from operators providing cellular voice service in localized markets, virtually controlling every aspect of the value chain, to an IP-based network of providers, each with varying controls and access to the end user relationship. As we examine different parts of the world and

[83] http://www.valuebasedmanagement.net/methods_porter_value_chain.html Michael E. Porter (born 1947) is the Bishop William Lawrence University Professor, based at Harvard Business School where he leads the Institute for Strategy and Competitiveness. Professor Porter is a leading authority on competitive strategy and the competitiveness and economic development of nations, states, and regions. He is a leading contributor to strategic management theory. His main objectives were to determine how a firm, or a region, can build a competitive advantage.

evaluate their wireless ecosystems, we will see that although their value chains may be at very early stages of development, this does not mean that they must sequentially go through the steps that advanced countries have gone through to catch up.

Advanced countries have built their wireless ecosystems as technology has advanced and as they could adopt. Existing legacy systems, in some cases, have held back application of the latest technologies to a degree, as new technologies have not provided sufficient return on investment to warrant replacement of existing, profitable systems. On the other hand, countries,[84] which lack infrastructure but are attracting foreign direct investment, have open and transparent administration and have deregulated monopolistic controls are able to adopt and implement the latest advanced technologies quickly and cost effectively, building ecosystems that are world level competitive in very short periods of time.[85]

The development of a competitive wireless ecosystem goes beyond operators, equipment manufacturers and application developers. Wireless ecosystems are driven by a region's ability and freedom to innovate, their access to markets, their access to capital and the motivating forces of competition. In the following section, we will give a brief overview of the evolution of the wireless value chain, particularly as it relates to cellular development, followed by an examination of the Wireless Ecosystem Value Chain, taking into consideration the regulatory and socio-political forces inherent in each region. In the third section we will examine the current wireless industry value chain, identifying the players and key roles in the current structure. In later sections we use the Wireless Ecosystem Value Chain to evaluate and compare countries and regions for competitiveness and opportunity.

A Brief Overview of Wireless Value Chain Evolution

Stepping back to 1990, cellular/wireless services primarily consisted of an operator with a network providing voice services to a geographically defined, relatively closed market. As services began to expand, we started to see companies providing specialized services and functionality to the operators who in turn, owned the client

[84] An example of this is the rapid expansion and adoption of cellular service in Europe in the 1980's. At that time, European landline technology was far below the quality of North America and user costs were very high for local and long distance calling. These factors, coupled with high population densities created an ideal climate for wireless. Today, most European countries have near 100 percent cellular penetration, far surpassing landlines, and they boast the most advanced technologies and applications in the western world, second only to Japan and Korea in the world.

[85] Estonia is an example of a country, which has developed an outstanding technology development ecosystem. As a former communist state, Estonia lacked infrastructure, people and skills. Motivated by foreign direct investment from Finland, Norway and Sweden, by membership into the European Economic Community and facilitated by an open, transparent and dedicated government, Estonia has become a powerhouse of ideas and applications affecting the world wireless and IP ecosystems. Estonia has produced Kazaa and Skype, revolutionary peer-to-peer applications. As of August 2005, Skype had over 60 million users worldwide and accounted for 47 percent of all VoIP traffic in North America.

relationship with customers. Handsets were relatively simple, growing with the markets appetite for advanced services.

Deregulation of markets, increased competition and advancing technologies all have had tremendous effect on the value chain and how markets operate but the single most influential factor in wireless services and telecommunications in general, is the move to IP-based services. The move to IP-based services has had several major effects in the wireless arena; the first is that it opened up the potential for new services that were not possible before such as:

- browsing;
- downloading content;
- online interaction with databases, dynamic information etc;
- the need for more advanced handsets;
- the need for more advanced technologies and equipment to meet the demands for bandwidth (EDGE, 3G, etc);
- the need for integration with other systems; and
- the need for customer interfaces and programming etc.

This has created many different sub-roles and sub-sectors to the value chain. At the beginning of this change, most of these sub-roles were taken on by operators or by operators in partnership with one or two specialist companies (see Figure 63).

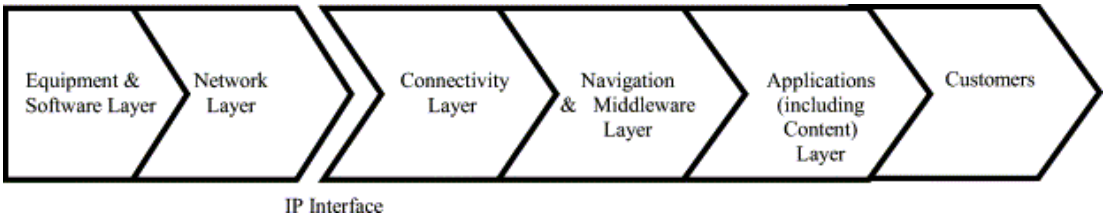


Figure 63 — The New Telecommunications Industry [86]

The next effect that the move to IP services had on telecommunications was to create opportunities for independent relationships to be built with end users from each stage of the value chain. In effect, this turned a relatively linear value path into a network of intertwined and interdependent value chains. The operators still have a power position

[86] Source: M. Fransman, *Evolution of the telecommunications industry into the Internet age*. Communications and Strategies 43 (2001), pp. 57–113.

within this structure, but this is changing as new business and revenue models such as MVNO's and new technologies such as WiMAX, WiBRO and WiFi mesh enter the scene.

The Wireless Value Network is an interconnection of various players (see Figure 64). It incorporates various players from financial institutions providing transactional capability to handset manufacturers providing specialized expertise in partnership with various parts of the value chain, with the operator, with a different partner or alone.

Another key effect of IP-based services is how they have reduced transactional costs. Before the Internet, procuring services, finding and interacting with suppliers and maintaining a cooperative relationship was a slow, time-consuming and costly activity. With the advent of IP-based communications (Internet and telecommunications) this process has been drastically streamlined. Before the Internet, it was cost effective and desirable to be a vertically integrated company, developing skills and capabilities in-house. Since the Internet, companies and operators alike have strived for a "Best of Breed" approach, concentrating on core strengths and outsourcing what can be done better and cheaper by specialists. The specialists are able to provide better services and lower prices by achieving the cost effective and organizational learning that comes with economies of scale.

The downside to this model is that differentiation becomes harder and harder to achieve, putting more and more emphasis on the customer relationship. A traditional operator maintains a physical network, aggregates content and services and manages the customer relationship. Under this model these become very different, specialized and sometimes conflicting activities resulting in weaknesses. Operators in highly competitive and open markets will have to start looking at new operating, revenue and business models before they are outmoded by those who can do it better.

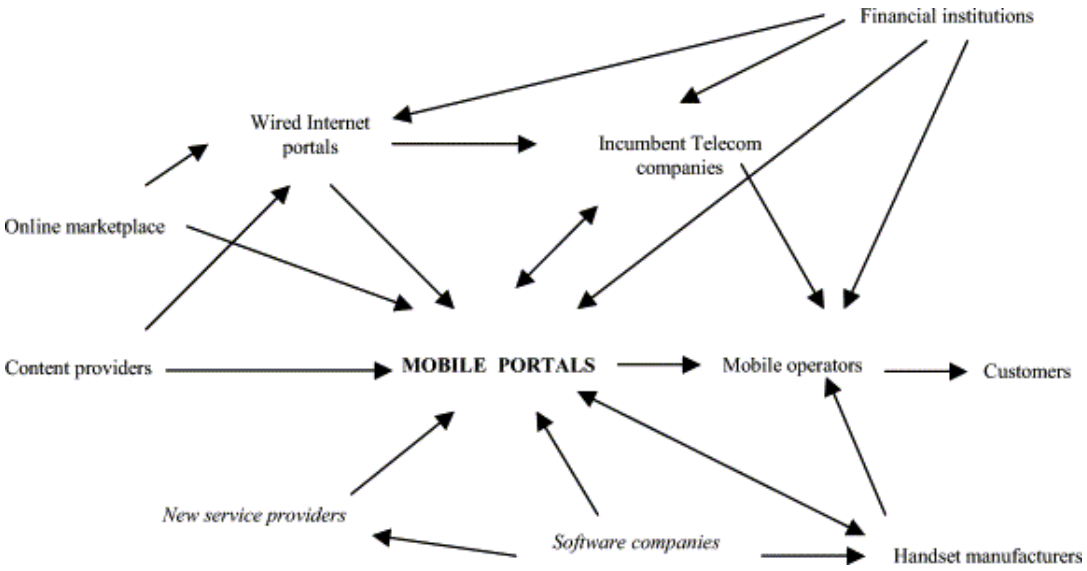


Figure 64 - Wireless Value Network[87]

The entrance of MVNOs into the telecommunications sector is a natural evolution to our open IP model. An example of an MVNO is Virgin, currently operating in the UK, Australia, US and Canada. Virgin does not own a network but it is a highly recognized brand world wide, with a distinct and successful philosophy and approach to customer relationship management. They operate on top of existing operator networks (local operators often become shareholders in the venture) providing the customer experience interface, the local operator simply providing the network. Virgin is a specialist in customer experience management and customer value creation, operating a network is not important to them as a core competency.

There are many different potential MVNOs, from recognized brands such as Wal-Mart and Disney to interested organizations such as banks, financial institutions, municipalities, educational institutions, hospitals and even condominium corporations. The barriers to entry into the wireless market have become low but are likely to drop even further with the advancement of new technologies such as WiMAX, WiFi Mesh Networks and WiBRO. These technologies will enable MVNOs to operate with little operator involvement other than interconnection and roaming.

Overall, the wireless value chain is a web of interconnected and rapidly evolving players. Each with a different value chain network, each has its own motivations. A banks' motivation may be to profit from transactions and to take a loss on connectivity, the opposite of a traditional operator. In a climate such as this, evaluating the wireless value chain must be seen within a greater context, particularly if we are to compare regions, countries and economic communities. The roles of government, transparency,

[87] Source: Feng Li and Jason Whalley. *Deconstruction of the telecommunications industry: from value chains to value networks*. Telecommunications Policy Volume 26, Issues 9-10 , October–November 2002, pp. 451–472.

corruption, competition, current technologies in use, social structure, wealth, access to capital, openness of market and regulation all play vital roles in creating an environment where new technologies, new business models and new ways of thinking can flourish. This is not only for cellular markets but for advanced and emerging technologies such as RFID, SCADA and WiMAX and for advanced services such as consulting, WiMAX deployment, Business Process Systems and others yet to come.

In the following section we look at the underlying factors that feed and develop the entire wireless ecosystem at a national level. A national wireless ecosystem is a complex and multi-connected web of components. We try to look beyond individual suppliers and manufacturers to define the value chain of the Wireless Ecosystem and in later chapters we will use this structure to evaluate wireless ecosystems worldwide.

The Wireless *Ecosystem* Value Chain

Inbound Logistics: Technology and Service Creation, Aggregation and Development

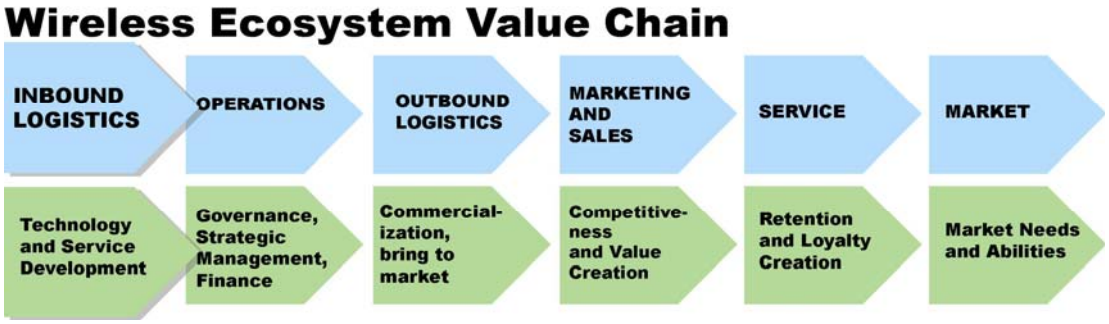


Figure 65 — The Wireless Ecosystem Value Chain

Inbound Logistics is an ecosystem's ability to foster innovation, develop and promote new technologies and new paradigms, generate free enterprise and invest in people.

Summary

The ability of a wireless ecosystem to create input is based on many factors. The strength, proliferation and openness of the ecosystem determines whether it can produce innovation, unique opportunities and differentiation that contributes to the overall productivity and wealth of the country or, if it can only meet the basic needs of its markets locally and must import expertise, technology, products and services as much as it is able.

Foreign direct investment can have a tremendous effect on local ecosystems as it brings in skills and innovation that otherwise would not have been locally developed.

An example of this has been taking place in India.[88] For several years, many large companies have been off-shoring research and development activities to India, maintaining their own premises and controls but taking advantage of the highly skilled and less costly workforce. As the skill set has developed, India has now become a primary outsourcing destination for research and development projects. In most cases, they are able to provide research R&D activities more efficiently than the parent corporation and provide a "global market" view.

The importance of interaction, open collaboration, joint ventures, openness of trade laws, civil liberties and R&D support cannot be underestimated. National Trade Associations and Regional Wireless Clusters can play an important role in developing important interaction between different levels of the value chain. Government plays a large part in the development of innovation through maintaining high governance standards, transparency, R&D support, educational support, international business support and regulatory foresight. The competitiveness of the market also plays an extremely important part as a key driver for innovation.

The more competitive a market becomes, the greater the need for refinement and innovation. The larger, the more active and the wealthier a market becomes, the greater the opportunity for successful commercialization of innovation and the greater potential for successful specialization. International development of Canadian companies and attraction of foreign companies to Canada's market will both increase the effective reach of the Canadian Wireless Ecosystem and increase competitive drivers at home, forcing innovation, new paradigms and new technologies.

Key Players

Equipment manufacturers and vendors; software developers and vendors; content creators, developers and aggregators, private and public; Governmental bodies, regulatory and supportive; wireless industry associations; wireless operators; system integrators; educational institutions; corporations; operators; foreign entrants

Components and Dependencies of Inbound Logistics

Hardware: Local development of handsets and handset technology, manufacturing; router, switch, antennae and chip development, testing and commercialization; ability to import hardware economically; provision of an economically feasible market for new technologies and hardware (purchasing power); view beyond local markets and present conditions; communications with other stages of value chain

[88] Source: Knowledge@Wharton, *In the End, R&D Has to Get Products to Market*, November 2005, http://knowledge.wharton.upenn.edu/index.cfm?fa=printArticle&ID=1273.

Software (applications): Local software development and testing; ability to import software solutions; provision of an attractive market for applications; view beyond local markets and present conditions; communications with other stages of value chain

System Integration: Wealth and drive of market to develop custom solutions and configurations; presence and promotion of advanced thinking and skills; competitive environment to drive the need for value creation, greater efficiencies and innovation

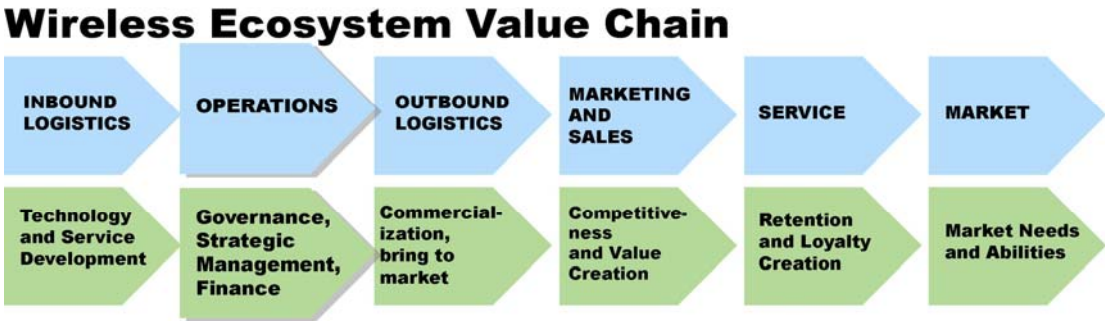
Content: Local content development (media, corporate, private, educational); communication/media oriented market; ability to import appropriate foreign content; provision and encouragement for the creation of content; freedom of arts, individuals, corporations and press; establishment of "open" structures (P2P, free press, disclosure requirements, privately owned media, etc); communications with other stages of value chain

System Innovation: Research and development support sufficient to allow consideration of new and innovative thinking, prototyping and development. Free of market forces; international collaboration; local pooling of resources and brainpower and cooperation/collaboration along value chain; joint ventures and FDI bringing international learning; international activities contributing to learnings in home market; corporate structures designed for innovation and speed to market; access to capital; transparency

Knowledge Base: availability of market information (transparency); educational base; private and public support for R&D, support of wireless clusters, joint ventures and other forms of collaboration; economic and social freedom to share information and ideas; international interaction; existing communications infrastructure

Investment: lack of corruption (transparency); investment in R&D; access to capital for local and international development; market potential; freedom to export and import; profitability; competitive need

Operations: Governance, Strategic Management, Access to Capital



Operations is how an ecosystem creates an environment conducive to partnering, foreign direct investment, business building, productivity, efficiency and advancement.

Summary

The value and competitive advantage created at the operational level can be measured by the efficiency of corporations, the transparency of governance and disclosure, the accountability inherent in the system, and the organizations ability to raise and implement capital, unfettered by the costs and limitations of corruption. Access to advanced thinking and technologies is also very important. These can come from educational institutions but can also come from professional organizations, experience and knowledge sharing of best practices in other industries and sectors. Openness of trade, exchange and communication also contribute a great deal to the development of operational excellence.

Vodafone Group Plc has been a tremendous influence worldwide for wireless operators. Since 1985 it has grown from a national carrier in the U.K. to the number two multinational force in over 40 countries with over 170 million subscribers. While Vodafone has struggled with this expansion, in the last two years, it has consolidated, and focused efforts to be a global player. By standardizing handsets, user experience, innovative billing structures and technologies worldwide, they have realized economies of scale unmatched in the world. These economies of scale have brought advanced Japanese handset technologies to the rest of the world. It has done similar things with services and content. Vodafone has made a tremendous impact on carriers worldwide by openly stating their commitment to completely replacing wireline services with wireless and building an active strategy based on that commitment.[89] Although some may argue that this may become less relevant in the next several years due to the development of IMS and converged wireline/wireless trends, they are

[89] Sources: Peter Bamford, MCO: *Delivering Vodafone live! With 3G,* http://www.vodafone.com/assets/files/en/3G_launch_peter_bamford.pdf. Arun Sarin, Chief Executive: *Blobal launch of Vodafone live! With 3G*: http://www.vodafone.com/assets/files/en/3G_launch_arun_sarin.pdf. Bill Morrow, CEO: *Vodafone UK Vodafone live! With 3G*: http://www.vodafone.com/assets/files/en/3G_launch_bill_morrow.pdf.

currently having a tremendous impact and influence on the wireless carrier sector worldwide.

Vodafone is an example of a company that has built a powerful advantage for its wireless ecosystem through operational excellence, management and governance.

In Canada, several of the major telecoms have put a great deal of effort and calculation into the deployment of services and features. Although not moving as fast as Asian or European counterparts, Canadians have taken a systematic approach, developing skills and experience at home as they solve the issues associated with dispersed populations and difficult geography. This has lead to some operators establishing international divisions, exporting expertise around the world, with varied success.

Many markets have implemented technology rapidly, driven by high-density populations. As these markets mature and reach saturation, the need to refine practices, better serve rural and dispersed populations and launch services under the constraints of ever tightening margins, has created a market for Canadian consulting expertise in business process improvement, service development and program deployment in regions that include Europe and Asia-Pacific.

Key Players

Equipment manufacturers and vendors; software developers and vendors; content creators, developers and aggregators, private and public; governmental bodies, regulatory and supportive; wireless industry associations; wireless operators; system integrators; educational institutions; corporations; operators; foreign players

Components and Dependencies of Operations

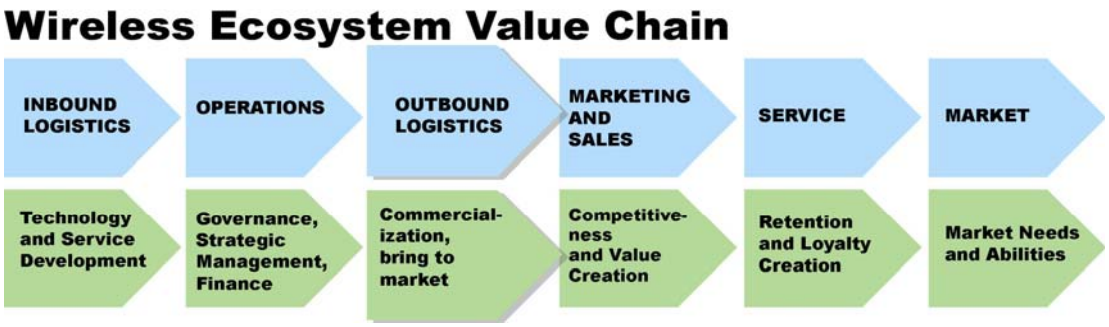
Governance: Transparency; capital structures; equitable tax structures; deregulation; open competition; experience and education of management; corruption; disclosure requirements; freedom to invest; communications with other stages of value chain

Strategic Management: Quality of educational Institutions; access to talent; high performance management infrastructure; access to consultants; competitive need; international market participation; communications with other stages of value chain; profitability; proximity to other corporations and industries (best practices); organizational learning ability; speed to market

Operational Science: Cost control; efficiency creation; six sigma; education; experience; collaboration and technology integration; adoption of modern practices

Access to Capital: Lending, investing infrastructure; transparency; corruption; interest rates and currency exchange; FDI; industry consolidation; regulation; disclosure requirements; proximity to capital markets; market potential; profitability

Outbound Logistics: Commercialization, Bring to Market



Outbound Logistics is dependent on an ecosystems ability to bring products to market, commercialize ideas, coordinate, execute, standardize and expand into larger markets.

Summary

When examining the Value Chain from the level of the wireless ecosystem, "Outbound Logistics" becomes the sector's ability to bring products to market, to establish distribution systems, to maintain branding elements, to expand into markets and to manage the whole process, leveraging the potential advantages of economies of scale and the organizational learnings of different markets. The ability of a company or sector achieving this can become a high value advantage.

Vodafone demonstrated their go to market ability when they launched Vodafone 3G Live! simultaneously in 13 countries. They have standardized handsets, offerings and user experience throughout all of their subsidiaries and partners to the point where they have taken on many non-equity partners who choose to brand themselves as Vodafone.

This was not always the case for Vodafone. In 2003, Arun Sarin took over as CEO and found that Vodafone had pursued an aggressive acquisition strategy, but had gained little advantage. In 2004, Mr. Sarin launched Vodafone's new strategic plan,[90] which consolidated operations, and established a structure that enabled multi-market rollouts, brand control, brand consistency and user value maximization. At the same time, the structure encouraged localization, the learnings of which came back to central management for rollout to all subsidiaries.

[90] Arun Sarin, Chief Executive: *Global launch of Vodafone live! With 3G*: http://www.vodafone.com/assets/files/en/3G_launch_arun_sarin.pdf.

Vodafone started as a local operator in the UK in 1985 and has grown to over 170 million subscribers worldwide. The skills that they have learned in the UK market have been exportable and likewise, the lessons that they have learned in over 40[91] countries have increased their competitive position in the UK. Although Vodafone is considered number two in the world (subscribers) with China Mobile at number one with over 200 million subscribers,[92] Vodafone has built a subscriber base through international acquisition and expansion whereas China Mobile's subscriber base is domestic.[93] Vodafone has built competitive advantage through outbound logistics by creating channels, reaching and entering markets, and by expanding and using economies of scale to advantage. China Mobile is number one in the world by subscriber base, but this is primarily due to an extremely large domestic market, of which they control approximately 31 percent (total market),[94] not from their ability to take products market and leverage economies of scale and scope.

As an example, TELUS Corp. of Canada has grown from a provincial incumbent to the number two wireless operator in Canada. They have done this through acquisition, market entry and distinctive branding. They have acquired local and regional operators, developed cooperative relationships, acted as consultants and have successfully competed with local incumbents throughout the country. TELUS has successfully built cooperative relationships in Asia-Pacific, establishing business and joint ventures in Philippines and South Korea through its subsidiary TELUS International. TELUS hasn't pursued the international acquisition strategy that Vodafone has, but as the wireless ecosystem evolves, over the next 3–8 years with converged telecommunication, TELUS has the potential to be a world player in the role of advisor and partner.

Key Players

Equipment manufacturers and vendors; software developers and vendors; content creators, developers and aggregators, private and public; Governmental bodies, regulatory and supportive; wireless industry associations; wireless operators; system integrators; educational institutions; corporations; operators; foreign players; infrastructure; MVNOs; large branded firms

Components and Dependencies of Outbound Logistics

Commercialization: Patent law; Intellectual property protection; existing channels and networks; economic activity; will to grow and expand; non-

[91] Source: Vodaphone websie : *Global Footnote*, http://www.vodafone.com/article_wide/0,3041,CATEGORY_ID%253D306%2526LANGUAGE_ID%253D0%2526CONTENT_ID%253D230772,00.html.
[92] Source: ITU, *Figure: Top 10 mobile operators by proportionate subscribers*, Dec. 2004 http://www.itu.int/ITU-D/ict/statistics/at_glance/topptoc_2004.html.
[93] http://www.chinanex.com/company/cnmobile.htm.
[94] http://www.chinanex.com/data/rev_op.htm.

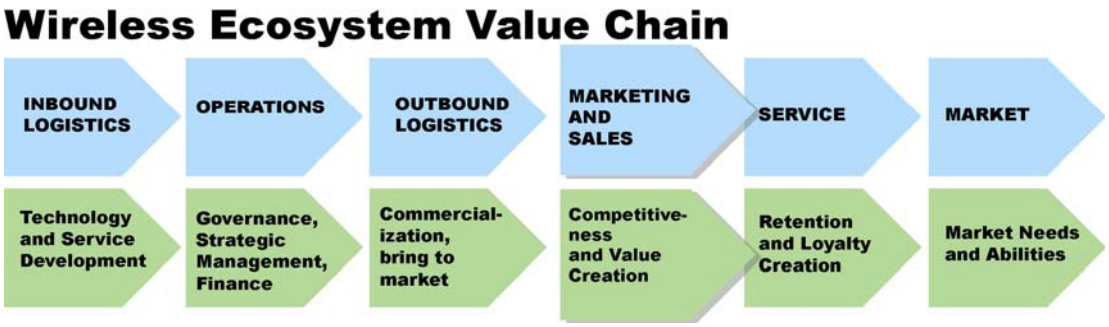
protectionist regulation; ease of entry; service/product delivery; costs of doing business

Channel Development: Ability to partner and build equitable and cooperative agreements; strength of contract law; corruption; transparency; foreign trade laws; local agents; black and grey markets; technology proliferation; brand control; commission structures; reach of existing channels

Business Planning: Transparency; capital structures; equitable tax structures; deregulation; open competition; experienced consultants; cultural differences; go to market ability/speed; credibility in market; negotiation style; experience, skill and education of management team

Expansion, Joint Venture and Consolidation: Transparency; capital structures; equitable tax structures; deregulation; open competition; experience; costs of doing business; government ownership; tax laws/treaties; disclosure laws; legal infrastructure; (foreign) ownership regulations; competition controls; brand development and integration; GAAP; currency exchange and repatriation; leveraging scale; localization

Marketing and Sales: Competitiveness and Value Creation



Value creation in Marketing and Sales, often dependent on lessons learned from a highly competitive market, is an ecosystem's ability to foster advanced thinking in customer relationship and experience management.

Summary

There is an old saying in business that is particularly relevant to marketing and sales:

"Ninety percent of success is attendance."

A competitive home market is probably the single most indicative measure of competitive strength within the value chain as it is a primary driver throughout.

The traditional formula for a successful international company is that they are usually highly successful in an extremely competitive home market. This was true for Vodafone as the UK is one of the most competitive in the world. In that market, Vodafone battles for first place with French O2 and German telecommunications firm T–Mobile, often separated by only 1 or 2 percentage points, the position determined by either subscribers or revenue. As well, Vodafone was not the incumbent by traditional standards but they were the first in the U.K., launching preemptively before British Telecom in 1985.

Understanding, calculating and acting on relative value is an uncommon skill and requires the ability to attach numbers to various shades of gray. It is the measurement of performance minus price within a competitive framework and most companies choose not to take a scientific approach but instead to rely on intuition, "gut feel" and following leaders.

Oskar Mobil, a wireless operator in the Czech Republic, previously owned by TIW, a Canadian wireless holding company that also owned Connex of Romania, was an example of Canadian expertise abroad. Oskar entered the market as a brand new player in 1999. They differentiated themselves as an inexpensive alternative operator with a personality and brand promise that leveraged Czech humour and indigenous culture. Oskar's advertising differentiated them from the other players, making a strong connection with the youth market. The population of Czech Republic was declining similar to most western countries but 40 percent of the entire population was between 50–59 and 25–34 (see Figure 66). When Oskar started in 1999, cellular was expensive and penetration sat close to 20 percent. The focus of Oskar's advertising and marketing was attracting new cellular buyers, in a distinctive Czech way at a very economical price.

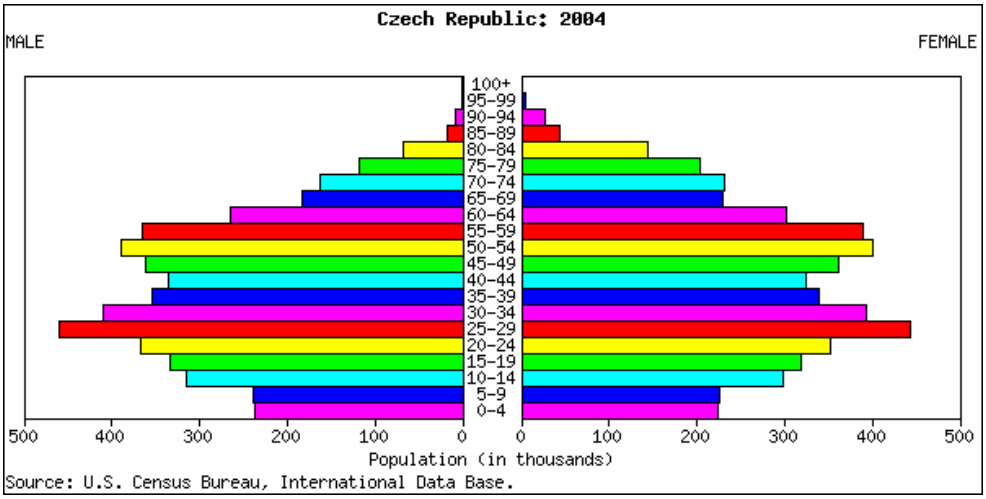


Figure 66 — Population Profile: Czech Republic 2004, by Age and Sex[95]

By 2004, the Czech market had become saturated. In a population of 10 million people, 12 million cellular accounts remained open. Oskar tried to reposition itself as an example of Czech know-how and leadership in action, an organization to be identified with and they focused on what they saw as high value clients, small business and the 30–34 age group. This included investing heavily in branding (internal and external), advertising and handset subsidies. In 2004, investment in advertising and costs associated with expanding branding and communication staff exceeded investment in the network.

As a market becomes mature, segmentation becomes more important, as does loyalty and retention, quality of service, performance to price ratios and service and support. Oskar focused on advertising and brand promise, without investing equally in service structures, network and quality of service resulting in high expectations but low levels of delivery. Of the three players in the market, it had the weakest network, the smallest selection of handset options and the lowest overall scope of services. Until 2003, Oskar was the fastest growing operator in Czech Republic but 2004 saw declining ARPU, declining net adds and escalating costs (while the competition showed growth). (see Figure 67).

[95] Source: U.S. Census Bureau, "Population Pyramids for Czech Republic" http://www.census.gov/cgi-bin/ipc/idbpyry.pl?cty=EZ&maxp=469435&maxa=100&ymax=300&yr=2004&.submit=Submit+Query.

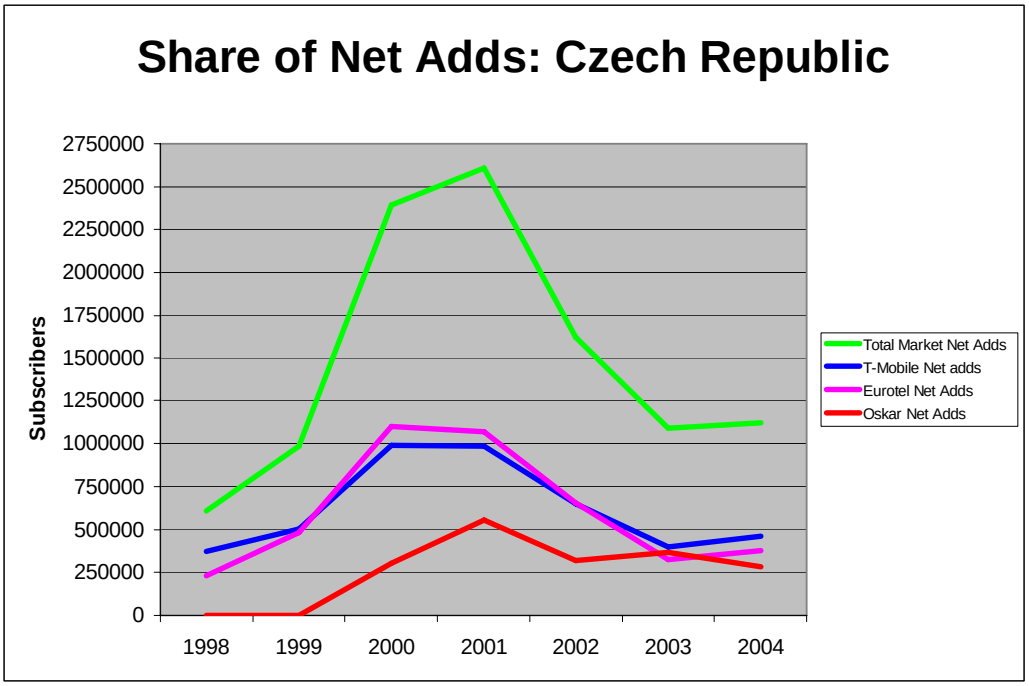


Figure 67 — Share of Net Adds, Czech Republic, 1998–2004 (Calculated from respective annual reports)

Differentiation is an extremely important aspect of marketing and branding is one of the most influential vehicles to achieve it. Understanding and managing competitive relative value (the complete relative competitive value minus relative competitive price) becomes more important as markets mature.

Dr. Larry E. Greiner[96] established the "Growth Phases Model Organizational Framework" in 1972 and it is still considered a valuable tool for understanding growth. He outlines the different stages of growth and how the transitions between those stages are often marked by a crisis of some form, often resulting in a major management change. The management and vision required to bring a company up from startup (in a brand new market) is often inappropriate and unsuccessful at later stages of growth (in a mature saturated market) (see Figure 68). Oskar and Connex were purchased collectively for approximately US$4B in 2005 by Vodafone Group.

[96] Dr. Larry E. Greiner's biography: http://www.clicklocal.com/documents/Evolution_and_Revolution.doc.

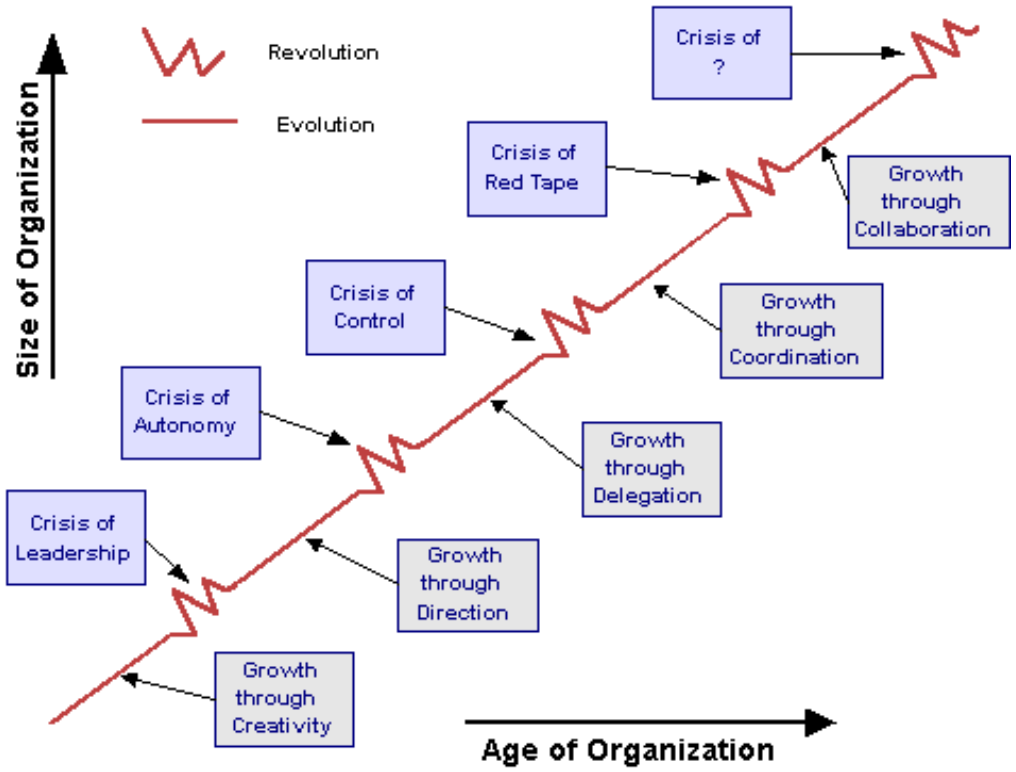


Figure 68 — Greiner's "Growth Phases Model Organizational Framework"

Achieving Success in Foreign Markets

Through informal interviews with industry participants, there is general agreement that Canadians have a reputation for being honest "gentleman negotiators" particularly compared to the US, but they also may have a reputation for unclear international strategy, for being slow moving and failing to follow through. Much of this impression has been attributed to the telecom industry in recent years.

Success in foreign markets is very dependent on understanding local markets and customs. Market entry in Europe is very different from market entry in the Gulf States, Pakistan or China. It is not uncommon for a company to be required to establish offices and presence in the Gulf States for several years before ever establishing a contract. Many states have restrictive laws governing foreign ownership and partnering with a local firm is the only option. In many countries, 90 percent of success is attendance and Canada's network of Trade Commissioners, Consulates and Embassies provide a crucial role.

Dr. Pittu Laungani[97] (UK), a noted expert on multi-cultural psychology, characterizes a key difference between east and west cultures as follows:

[97] Dr. Pittu Laungani's list of published works, http://cdcp.oise.utoronto.ca/CMCConf2005/pdfs/pittucv.pdf.

In the west, friendships and relationships are incidental to work and career

In the east, *work and career are incidental to friendships and relationships*

In later chapters, we will evaluate Canada's ability to market domestically and internationally and we will also evaluate the attractiveness of different markets, accounting for business costs, personal risk and business risk.

Key Players

Equipment manufacturers and vendors; software developers and vendors; content creators, developers and aggregators, private and public; governmental bodies, regulatory and supportive; wireless industry associations; wireless operators; system integrators; educational institutions; corporations; operators; foreign players; infrastructure; MVNOs; advertising and marketing firms; market research firms

Components and Dependencies of Marketing and Sales

Competitiveness: Open competition; deregulation; demanding market; maturity of market; penetration; concentrated population

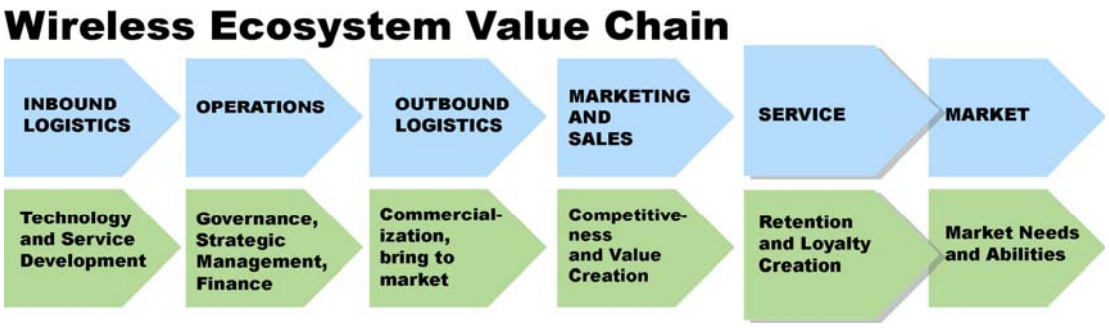
Relative Value/Value Creation/Market Insight: Experience, skills and education of management; competitive drivers; resources; stages of corporate development; localization; best practices; bundling and packaging; retailing/sales ability; networking ability; flexibility; ability to act

Segmentation: maturity of market; competitiveness of market; demographics; skills and experience of management; availability of human resources

Retailing/Sales Force: foreign ownership laws; tax regulations; real estate investment requirements; ownership laws; corruption; costs of doing business; personal risk

Branding/Differentiation: Branding experience of management; local creative talent; positioning, MVNO

Service: Retention and Loyalty Creation



Service examines an ecosystems ability to competitively meet the needs of end users, not just answering requests, but understanding and anticipating needs to the point of creating competitive value and innovation.

Summary

Service and support become key elements of the value chain as they determine whether customers stay with you, recommend you or consider more products and services. Relationships with the organization are won and lost at service, regardless of product attributes.

As markets mature and there are fewer "new" customers to win, loyalty and retention become paramount as you try to win customers from your competition and vice versa. Canadian companies have built strong loyal followings through understanding of user experience and by building structures for the analysis and tracking of data.

SK Telecom operates in the large, technically savvy South Korean market. They were one of the first to introduce mobile TV. They introduced the service with a flat rate fee of approximately CDN$20/month. The program had extremely successful adoption rates but the network had so much use that the bandwidth requirements crippled the network, destroying quality of service for the "bread and butter" voice and data customers. They quickly changed the tariff structure to "packet" based, resulting in flat rate customers suddenly receiving a monthly charge between CDN$400–600. SK Telecom had a massive inflow of complaints and lost some of its highest-value customers. SK Telecom quickly understood that loyalty and retention were areas that they lacked expertise, to the point where it was costing them competitive value.

To win a new client, the cost is approximately five times the cost of retaining a current client. Training and incentives for sales staff also become important considerations as their motivations can sometimes conflict with the needs of the corporation. It is not uncommon for sales staff, which are paid based on sales commissions, to also be responsible for providing levels of service and support. This scenario can result in sales

staff “brushing off” service clients, rushing for the next sale, leaving clients with nowhere to go but the competition.

Key Players

Equipment manufacturers and vendors; software developers and vendors; content creators, developers and aggregators, private and public; governmental bodies, regulatory and supportive; wireless industry associations; wireless operators; system integrators; educational institutions; corporations; operators; foreign players; infrastructure; MVNOs; advertising and marketing firms; market research firms

Components and Dependencies of Service

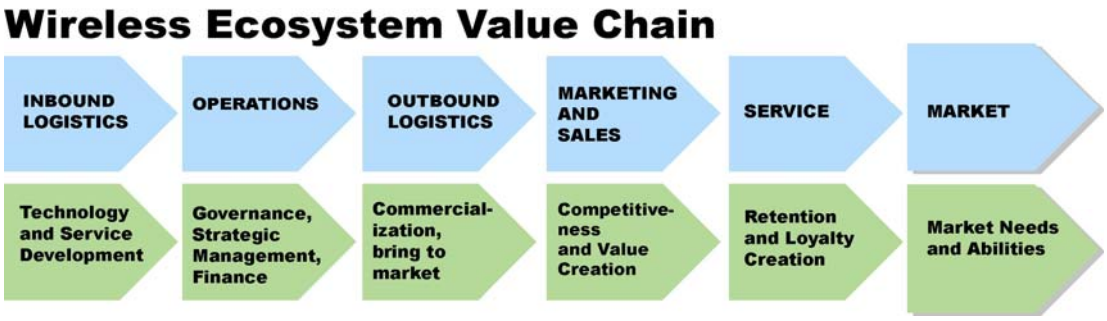
Retention: Maturity of markets; customer lifecycle management; data management; CRM; competitive relative value analysis; key performance indicator analysis; complaint recovery; expectation management

Loyalty Creation: Branding and promise fulfillment; competitive Positioning; niche marketing; mass customization; relationship building; cultural relevance and appropriateness;

Support: Call centre capabilities; AVR; online services; customer education; effective and inventive use of sales resources

Incentive Design and HR Management: Commission structures for sales and support staff; training; education; internal branding; availability of resources

Market: Market Needs and Abilities



Market is what drives innovation, localization and advancement. Without market there would be no need for an ecosystem. A supportive and hungry market is the key driver for the wireless ecosystem.

Summary

The most important component of the value chain model is market. Without a market, all the other parts of the value chain become meaningless. For sales of cellular service to be possible, a population must exist that can afford to pay for it. For the sale of content to be possible, handsets that are compatible with content must be in place. When looking at new markets, a company must look at the risks involved such as: Will we get paid? Will the costs of corruption and bureaucratic inefficiency eat up any potential profits? Will what we learn from this market, help us in our own markets? The best business plan in the world will not work without a market.

In 2003, the United Nations released a report compiled by the Adam Smith Institute on the Economics of Free Speech.[98]The report is a collection of papers on many different aspects of how civil liberties affect commerce, economic well-being and their implications on quality of life. Djankov (et al)[99] analyzes the characteristics of societies where media is controlled by government. Through multiple examples and statistical analysis, they refute the common opinion that government controlled media is positive for a society as media access is a public good that must be provided above the principles of commerce. The data they present proves the opposite with significant correlations between government control of media and high poverty, high mortality, low education, low prosperity, high unrest, high crime and generally, the lowest standards of living known to man. Their study does not conclude that government control of media is the only or root cause, but they do establish that these indicators signal the presence of each other. The World Bank's Human Development Index (HDI) also uses many of the same measures to rank the developmental position of over 240 countries. We will look at some of these indicators in later chapters as a means of measuring risks, costs and opportunities.

Key Players

Governments; equipment manufacturers and vendors; software developers and vendors; content creators, developers and aggregators, private and public; wireless industry associations; wireless operators; system integrators; educational institutions; corporations; operators; foreign players; infrastructure; MVNOs; advertising and marketing firms; market research firms

Components and Dependencies of Market

GDP: Wealth and standard of living; poverty; hunger; Gross Domestic Product (GDP) per capita; productivity; disposable income; disparity between rich and poor; presence of middle class; growth

[98] Source: World Bank, T*he right to tell: the role of mass media in economic development, volume* , November 2002, http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000094946_02111404075733.

[99] Source: Simeon Djankov, Caralee McLiesh, Tatiana Nenova and Andre Shleifer: *Media Ownership and Prosperity*, pg 141.

Demographics: Percentage of population under 30; size of population; education levels; urban concentrations; lifestyle support for technologies; contagion; interest

Civil Liberties: Freedom of Speech; Freedom of Travel; economic freedom; human rights record; contagion;

Government Control: Public vs. private ownership; trade agreements; protectionist policies; corruption and bribery; regulation; foreign ownership

Costs of Doing Business: Corruption; transparency; strength of contract law; income repatriation charges; duties and tariffs; transparency; banking infrastructure

Risk: personal risk; risk of failure due to outside forces; transparency; risk of not getting paid; risk of capital loss due to insurgence

Foreign Direct Investment: Attraction of market; FDI performance; FDI presence; FDI as an incentive to accommodate foreign business; membership in World Trade Organization (WTO)/ EU/ other trade treaties; trade treaties with Canada

The Wireless Industry Value Chain

A Micro View of the Players and Roles in the Current Wireless Sector

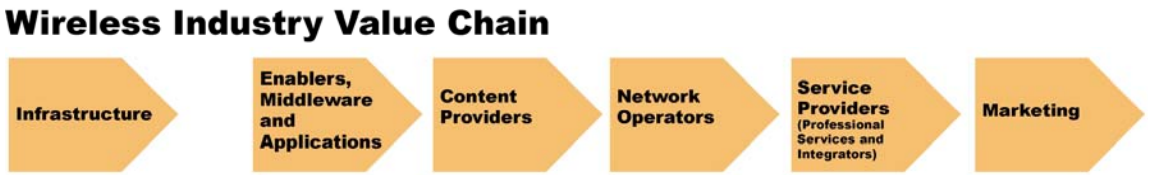
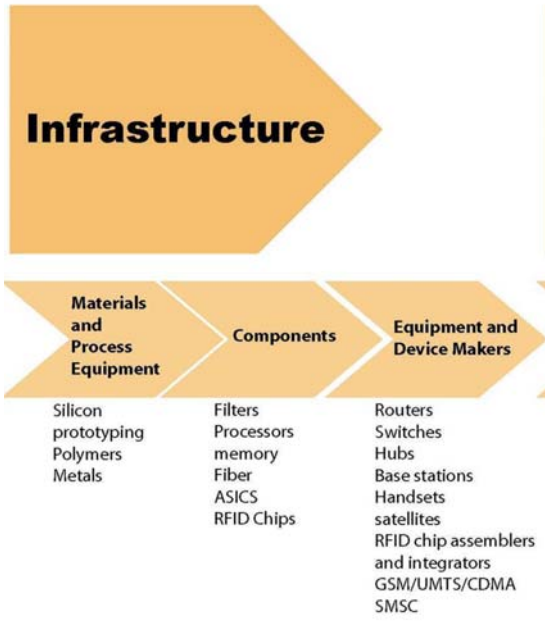


Figure 69 — Wireless Industry Value Chain, High Level View

In the Wireless Ecosystem Value Chain (see Figure 69), we defined the factors of a country or region that are the underlying drivers and enablers that create a prosperous wireless ecosystem. In this section we examine the micro level including players and roles that are current within Canada.

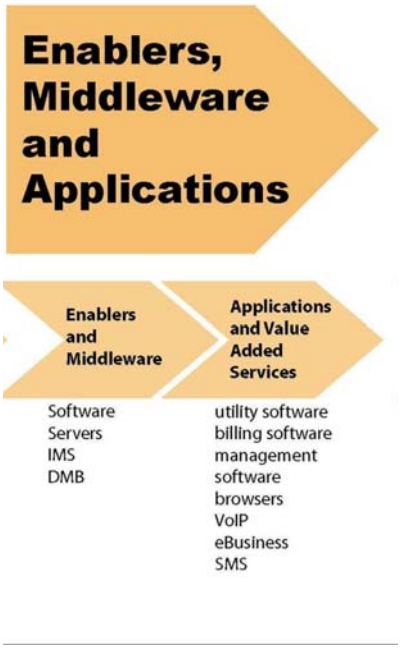
Infrastructure

The 'Infrastructure' link of the Wireless Industry Value Chain is divided into three sub groups (Materials and Process Equipment; Components, and Equipment and Device Makers). Each sub group has attributes as seen below:



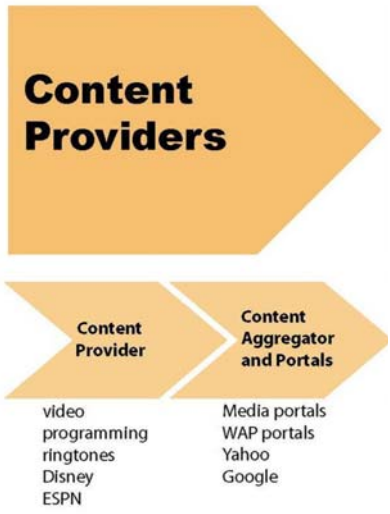
Enablers, Middleware and Applications

We have combined Enablers and Middleware and Applications in the Value Chain as they are often co-dependent and co-reliant. Their attributes can be seen below:



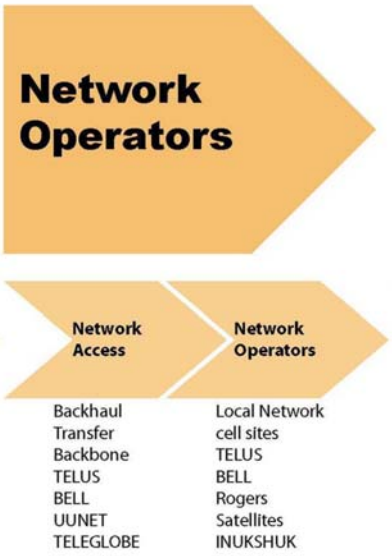
Content Providers

The 'Content Providers' link of the Wireless Industry Value Chain is divided into two sub groups (Content Provider and Content Aggregators and Portals). Their attributes as seen below:



Network Operators

In the Value Chain the network operators encompasses both network access to backbone connections and local network operators. The attributes are given below:



Service Providers (Professional Services and Integrators)

Traditional service providers, System Integrators and Professional Services work very closely on a continual basis. Professional services are very relevant and useful in every step of the value chain but not to the significance of the relationship with Service providers. With new technologies such as RFID and to some extent WIFI, WiMAX and others, the system integrator becomes the servie provider. We have combined the two to show this relationship in the Value Chain.

Marketing

Recognizing the different roles involved in selling and establishing clientele, and the different industries dedicated to facets of these roles, we have divided marketing portion of the Value Chain into 3 components seen below:

Conclusion

The Wireless Ecosystem is a complex web of interconnected value chains and value networks (see Figure 70). This web is changing rapidly, driven by open markets, innovation, productivity and underlying markets. To be able to evaluate ecosystems worldwide, we must evaluate the structures in place that support these activities, foster innovation and motivate advancement. By evaluating these structures on both a micro and macro level, in later chapters we will determine the relative positioning, strengths and opportunities for Canadian wireless companies.

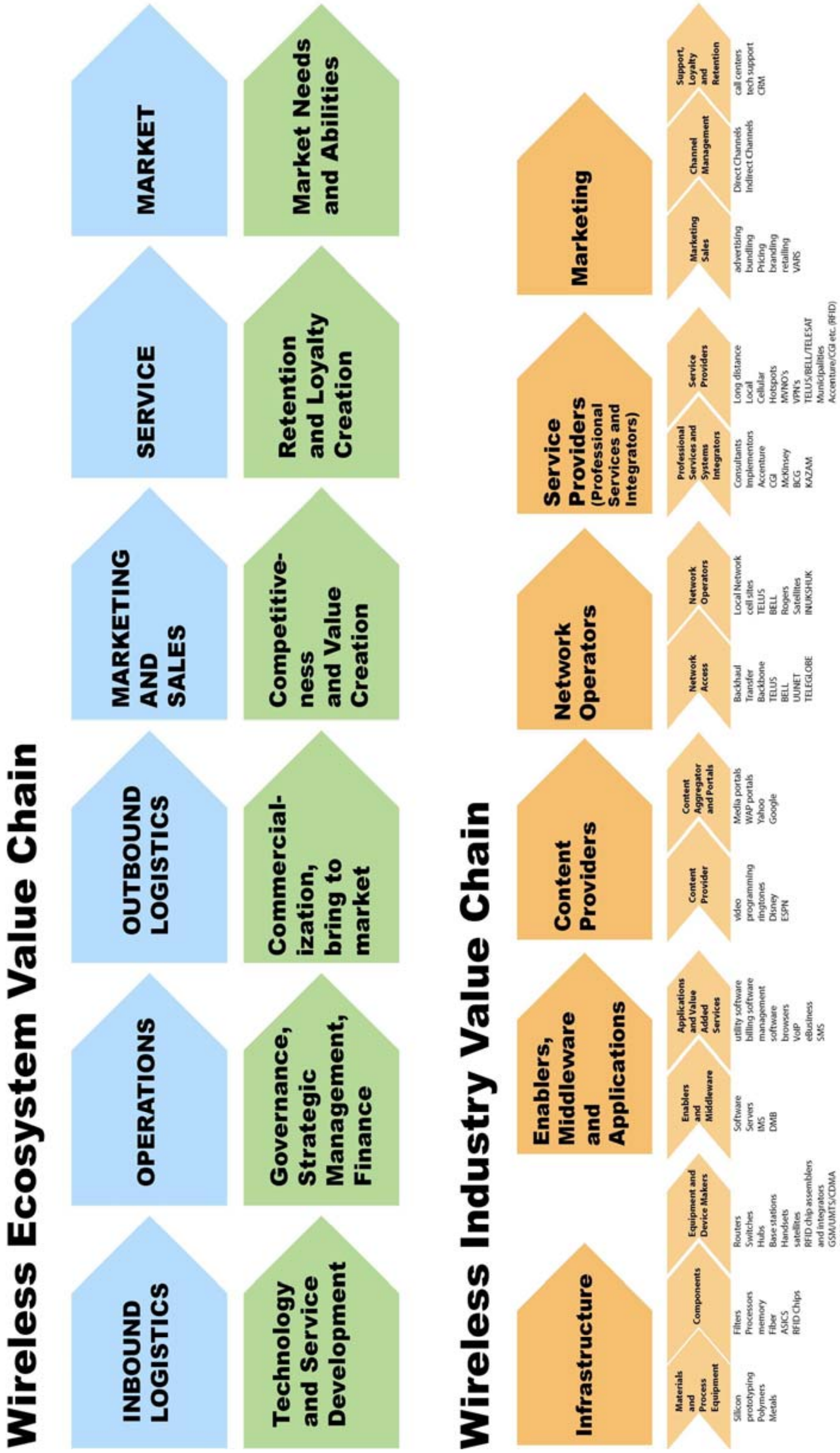


Figure 70 — The Macro/Micro Wireless Value Chain

Chapter

4

Part 2: Positioning of the Canadian Wireless Industry

Positioning of the Canadian Wireless Industry

Canadian Wireless Industry Overview

Market Dynamics

The Canadian wireless telecommunications industry represents almost 30 percent of the Canadian telecommunications market, with over CAN$10B in revenues a year. The Canadian wireless industry has been experiencing an annual growth rate three times that of any other sector in telecommunications. This is significant for a country that is in the top 10 percent of the world for broadband Internet penetration and amongst the worlds leading countries for tele-density. The Canadian wireless telecommunications market is expected to generate over CAN$15B by 2009, representing an 11.5 percent compound five year growth from 2005 to 2009.[100] While this represents about 8 percent of the US market, which currently stands at over US$122B, the Canadian wireless market is growing at a faster pace than our US counterpart, which is growing at 10 percent annually.

Approach to the Positioning of the Canadian Wireless Industry

Areas of Leadership, Strength, Developing and Lagging

In this section, we position the relative leadership, strengths, and weaknesses of the Canadian wireless ecosystem, as well as present the opportunities available in Global markets.

- Technology and industry *leadership* areas are those where key Canadian companies have the largest market share in the world, or are the most innovative in their industry sub-sector, or have the most intellectual property rights.

[100] Source: IDC, *Wireless Wars 2: Canadian Wireless Forecast and Analysis, 2005-2009,* http://www.idc.com/getdoc.jsp?containerId=CA1712TMS.

- Technology and overall industry *strength* includes wireless sub sectors in which several innovative Canadian companies are present with significant exports to markets around the world.
- *Developing* areas are those in which Canadian companies or the industry as a whole has some strength, but also faces a lot of challenges. These challenges must be overcome in order for us to move up into the strength category.
- Technology or the industry as a whole is considered *lagging* when few Canadian companies are present with limited innovation and few exports to worldwide markets.

Comparison to Mature Markets

Throughout this section, we compare the Canadian wireless ecosystem to the US and South Korea. The US was chosen because: of its proximity to Canada, it is our largest trading partner, and most Canadian wireless companies export or plan to export to the US. Similar business practices and traditional alignment from a technology, network, spectrum and roaming perspective for cellular are seen as important considerations for comparison to the US.

South Korea was chosen because it is considered to be a global leader when it comes to several facets of the wireless industry. These include technologies and deployment maturity for cellular, mobile broadcast, wireless MAN, handsets, content and applications. The market and industry leadership South Korea presents in both the aggressive internal consumption of new technologies, products and services, and the export of them internationally, presents several insights from which the Canadian wireless industry can draw guidance.

The South Korean wireless industry has challenges in access to resources (both investment and skilled people) as compared to Canada. However, when it comes to using what it has and developing new products and then taking them to international markets, South Korea far excels Canada. We explore areas where South Korea excels, and throughout this section leverage examples to showcase how things are done differently in South Korea, and what lessons can be derived.

Differences in Consumer Behaviour

In comparing with South Korea, especially as it relates to services for consumers, there is often a perception that somehow the South Korean consumer is vastly different from the Canadian consumer, and therefore things that may work in South Korea may not work in Canada. While differences do exist in some aspects of consumer behaviour, and it is true that not all things

that work in South Korea can be simply transported without alteration to Canada,[101] there are many consistencies in the consumer experience.

Firstly, Canada has a diverse consumer base, and youth represent a large part of the current and future target market for mobile services in Canada. The shear lack of cellular penetration in Canada has not resulted in segmentation and targeted marketing to the youth to the same extent as it is in South Korea. However, we find that where we do launch services that were launched in South Korea several years ago, that these services, for the most part, produce similar results as in South Korea. For instance, ringtones, MP3 music over cellphones, MPEG4-based streaming mobile TV, and games were all very popular in South Korea, and experience has shown these services to be the most popular in Canada. Likewise, cellular location based services (AGPS) were not very successful in South Korea, and the Canadian experience shows similar results thus far. The challenges with LBS included lack of accuracy in urban areas, and customer privacy concerns. M-commerce, which has traditionally not been very successful thus far in many markets, was relatively more successful in South Korea, but its success took a lot of investment by the operators, partnering with established financial institutions, and influence over handset manufacturers to embed an m-commerce capable chipset into handsets. While Canadian operators are now following suit, it's still early to predict the outcome for m-commerce in Canada. Needless-to say the European Simpay experience was less than encouraging, which resulted from differences in approach between operators, and the consortium biting off more than it could chew. The South Korean market has already launched WiBRO (very similar to WiMAX) for WMAN applications as well as Mobile Broadcast services. Canada is likely to see WMAN prior to mobile broadcast, but both of these service launches in South Korea offer experiences that can be leveraged when assessing the Canadian wireless ecosystem.

We use South Korea for comparison for internal consumption of new technology. This is because experience shows us that a dynamic and aggressive local market that consumes new technologies and services helps to prepare local vendors by allowing them to trial and launch their products locally, and to build reference clientele prior to exporting their products internationally.

[101] KAZAM has worked with several western companies seeking to learn from the experience of South Korea and Japan and to take these lessons and tailor them to the local needs of the market of interest. This is by no means an easy task, but it is highly beneficial for operators and vendors to learn from other's experiences without repeating their mistakes.

Strengths and Weaknesses in the Value Chain

Canadian companies are well represented in many segments of the wireless industry value chain. They are frequently found to be among the most innovative companies around the world. The Government of Canada's tax benefits and incentive programs for R&D, as well as the prevalence of a highly educated workforce have fostered this culture of innovation.

Below is a summary of Canadian companies' capabilities along the value chain in the various sub-sectors of the wireless industry.

- **Leadership**
    - Cellular Equipment (core and access technologies)
    - Data-centric mobile devices and CPEs
    - WiMAX
    - Software Defined Radio (SDR)
- **Strength**
    - Innovation and entrepreneurship
    - IP infrastructure for next generation networks (IMS/MMD) and Mobile Service Enablers (SMSC, MMSC, Media Gateways etc.)
    - WiFi Mesh Networks
    - Semiconductors
    - Professional services
- **Developing**
    - Mobile content
    - RFID
    - Cellular Industry
- **Lagging**
    - Cellular Handsets
    - WiFi Access Points (AP) and CPEs
    - Ultra Wideband (UWB)

Key Areas of Market Leadership and Global Potential

Cellular Equipment

Canada is a leader in the cellular infrastructure market primarily because of the scale of Nortel's presence in the different cellular markets around the world. Nortel equipment is quite prevalent in North America, Latin America and Europe. In the Asia Pacific market, Nortel is already present in the two largest developing markets in the world, China and India. Nortel is also present in MENA as well as South Africa. Nortel also has an extensive network of offices internationally, facilitating sales and support services.

According to IDC, the world cellular infrastructure market (2.5/3G) is expected to grow at a CAGR of approximately 3 percent between 2006 (see Figure 71) and 2008 (see Figure 72). Western Europe and Asia Pacific will lead the way in growth rates with the market in these two regions expected to growth at a CAGR of 8 percent and almost 3 percent respectively. North America will be the only market to experience a decline in cellular equipment spending with CAGR expected to be -1.71 percent. The rest of the world, which includes Latin America, Eastern Europe and MEA, will also increase at a modest CAGR of nearly 2 percent.[102]

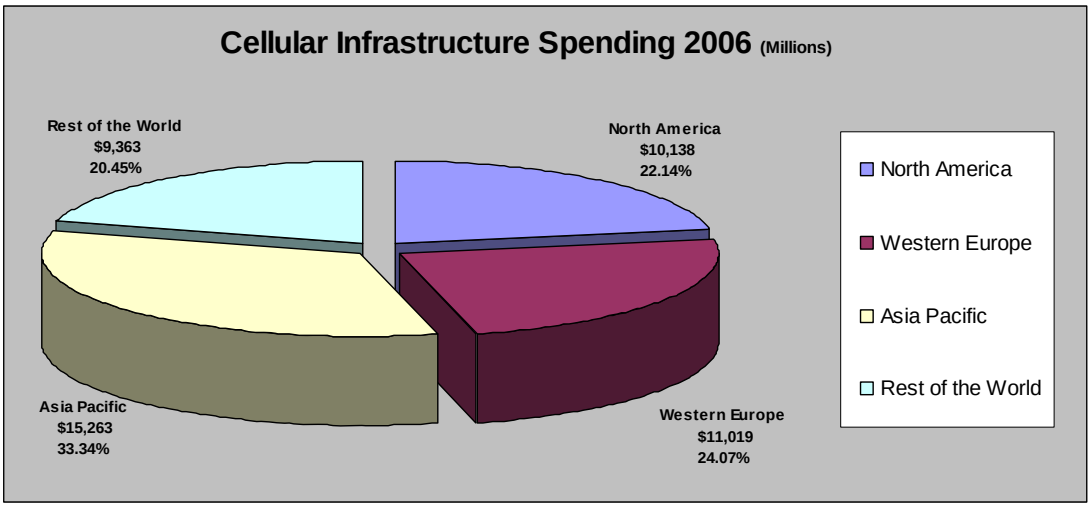


Figure 71 — Cellular Infrastructure Spending 2006[102]

[102] Source: *IDC Worldwide Wireless and Mobile Network Infrastructure 2004 – 2008 Forecast and Analysis*, December 2004. Note that market projections exclude PDC/TDMA/iDEN and TD-SCDMA technologies.

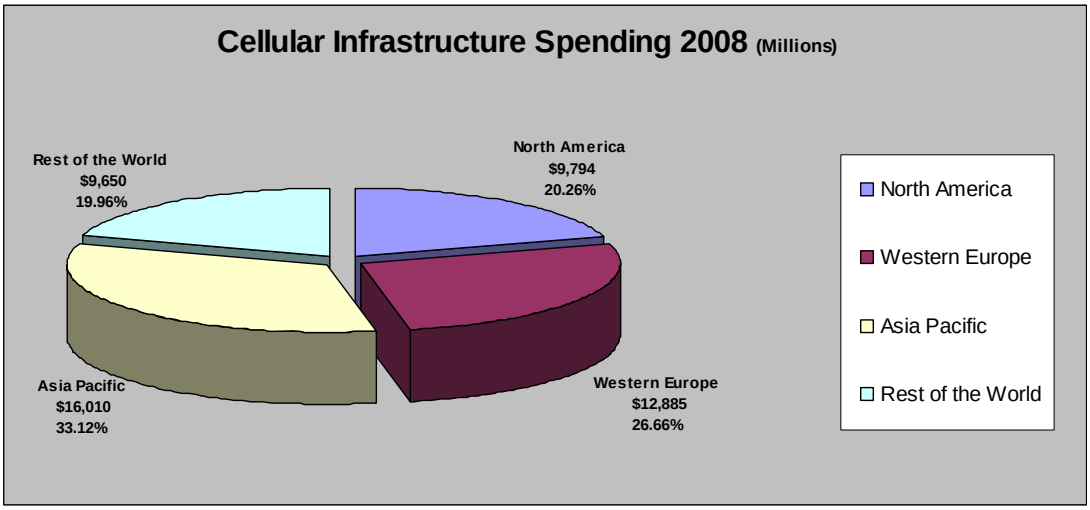


Figure 72 — Cellular Infrastructure Spending 2008[102]

Data Centric Mobile Devices and CPEs

Canadian companies that are leaders in commercializing data-centric mobile devices and CPE's include RIM with its Blackberry™ device, and Sierra Wireless with its AirCards.

RIM has leadership in the push email market and uses a proprietary operating system (OS) on its devices. While the combination of push email and security have given RIM an early advantage, it faces stiff competition in this space from some of the world's largest smartphone and PDA manufacturers such as Nokia and Palm. Microsoft is also looking to gain market share on RIM by offering an Outlook synchronization solution for data centric mobile devices. As a result, RIM is expected to face growing competition. On the bright side, the market for data centric devices and smartphones is growing in multiple regions around the world.

Sierra Wireless is another Canadian company that leads the market in offering cellular AirCards. Sierra Wireless has been able to expand its share of the world market by establishing an office presence in Latin America, Europe and Asia-Pacific.

As the emerging markets around the world, in Latin America, Eastern Europe, MEA, and parts of Asia-Pacific, grow in cellular subscribers they will represent opportunity for Canadian companies looking to sell data centric mobile devices.

WiMAX

Canada is a leader in WiMAX with a significant number of companies conducting R&D into and commercializing WiMAX products. Redline Communications recently announced that they are now offering the world's first complete WiMAX product line that is WiMAX forum certified. There are many Canadian companies that are on the forefront of WiMAX research that are exporting their products (in some cases pre-WiMAX equipment for backhaul connection) to markets around the world including Wavesat Inc. and Vcom Inc. Wavesat received an award from Frost & Sullivan in 2005 recognizing it for its innovation for the development of OFDM chipsets for WiMAX.

KAZAM believes that the market for WiMAX is significant as revenues in 2006 are expected to approach half a billion dollars and will grow to over $3B by 2009 (see Figure 73).[103] Canadian companies should leverage their position as leaders and establish a foothold in the different markets around the world as WiMAX adoption continues. This will put them in a prime position to reap the rewards once WiMAX catches on and the market growth becomes exponential.

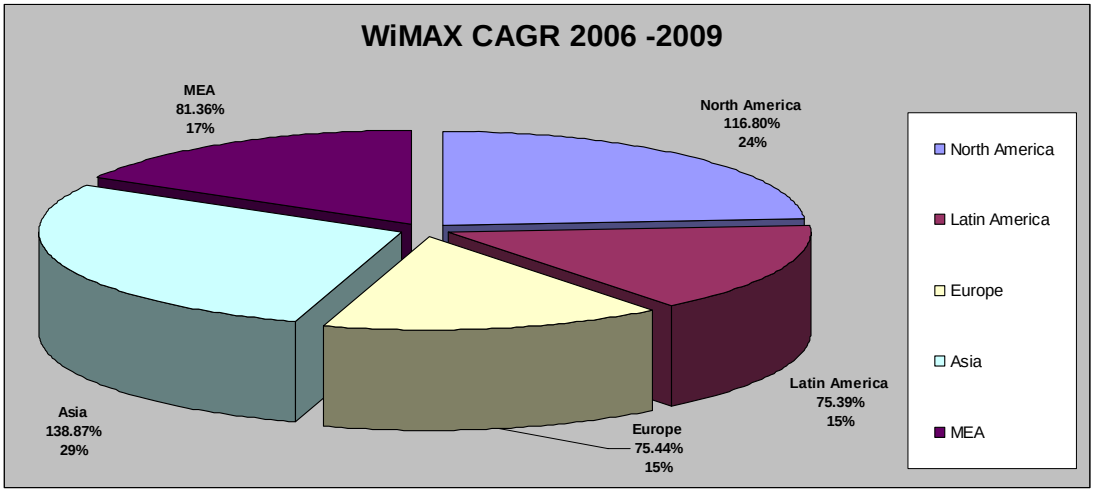


Figure 73 — WiMAX CAGR 2006–09[103]

Software Defined Radio

Canada has leadership in SDR from both a company and a government perspective. Spectrum Signal Processing is a Canadian company that has been able to successfully commercialize SDR and has an extensive list of customers, which are predominantly in the defense and satellite industries. The Communications Research Centre Canada (CRC) is a pioneer in SDR research, which has been used by companies and institutions around the world.

[103] KAZAM WiMAX Forecasts, 2006.

SDR is being used in the defense industry. The US Department of Defense is promoting SDR to replace dispersed radio technologies with a single software-based solution. Consumer applications of SDR are also emerging. A case in point is the deployment of an SDR driven GSM base station system by Vanu by Ice Wireless in the Northwest Territories in 2005.

Key Areas of Strength and Global Potential

Strength in Innovation and Entrepreneurship

While Canadian companies consist of market leaders including Nortel and RIM, the backbone of the Canadian wireless industry is represented by a large majority of small to mid-sized and highly innovative companies. These companies participate across many areas of the wireless value chain. The common areas of strength for these companies include innovation, R&D, quality of product and high standards of customer care. If the world average for the following metrics were normalized, Canada would place[104]:

- 23 percent above the world average for access to capital for entrepreneurs (US at 28 percent, UK at 32 percent, Germany at 14 percent, Japan at 12 percent, South Korea at 5 percent);
- 32 percent above the world average for technological activity[105] (US at 39 percent, UK at 26 percent, Germany at 31 percent, Japan at 37 percent, South Korea at 19 percent); and
- in the top 10 countries in the world for innovation.

Canadian companies are active across multiple sectors including: cellular infrastructure and enablers (including 3G, IMS); data centric devices; Wireless WMAN solutions including WiMAX and WiFi-based Wireless Mesh solutions; and in the production and aggregation of content.

Participation in High Growth and Emerging Technologies

Overall, the strengths in the Canadian Industry are in the area of products with high R&D components, i.e. OFDM, WiMAX, Wireless Mesh, and 3G. Participating companies include: Wi-LAN, Redline Communications, BelAir Networks and Nortel. Software intense products are also an area of strength, i.e. middleware, applications and value-added services. Canadian companies participating in this category include OZ, which supports messaging; SIPquest, which supports SIP-based multimedia solutions; and Redknee, which supports a multitude of enablers for data services.

As a result of market strength, leadership or the number of active companies participating in an area, Canada shows strength in the following key areas of growth:

[104] Source: Milken Institute, Best Markets for Entrepreneurial Finance, Capital Access Index 2005, Securitization in Financing Economic Activities, October 2005, http://www.milkeninstitute.org/publications/publications.taf?cat=PBriefs&function=detail&ID=459.

[105] Source: UNCTAD, *World Investment Report 2005*, http://www.unctad.org/en/docs/wir2005_en.pdf.

- OFDM and WiMAX, and Wireless Mesh (Technical leadership, number of participants);
- Software — Middleware and Applications (number of participants); and
- Devices — Data centric devices (Leadership).

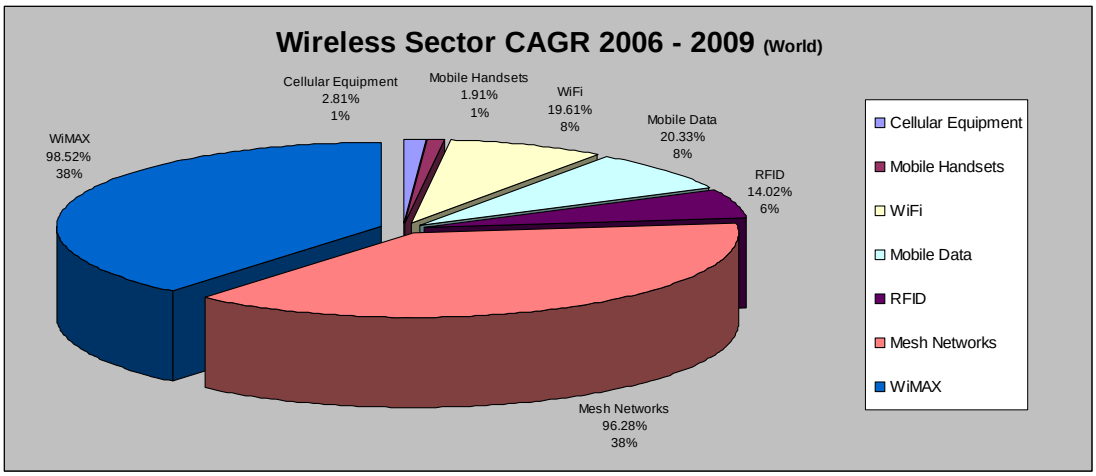


Figure 74 —. Wireless Sector CAGR 2006-09[106]

While Figure 74 shows areas of growth, it is important to consider the amount of money being spent in these sectors. Figure 75 illustrates the amount of money being spent, and shows that while WiMAX and Wireless Mesh growth is significant, the actual amount of growth in money being spent in these areas is a very small percentage of the overall market. The drastic change in growth is expected as the existing installed base for WiMAX and Wireless Mesh is nominal relative to cellular and the expectations for both WiMAX and Wireless Mesh are high.

[106] KAZAM Wireless Sector Forecasts, 2006. Figure shows change in Projected Market Growth across wireless sectors from 2006–09. The first number represents actual projected change of the sector and the 2nd number is the percentage of total change across all wireless sectors

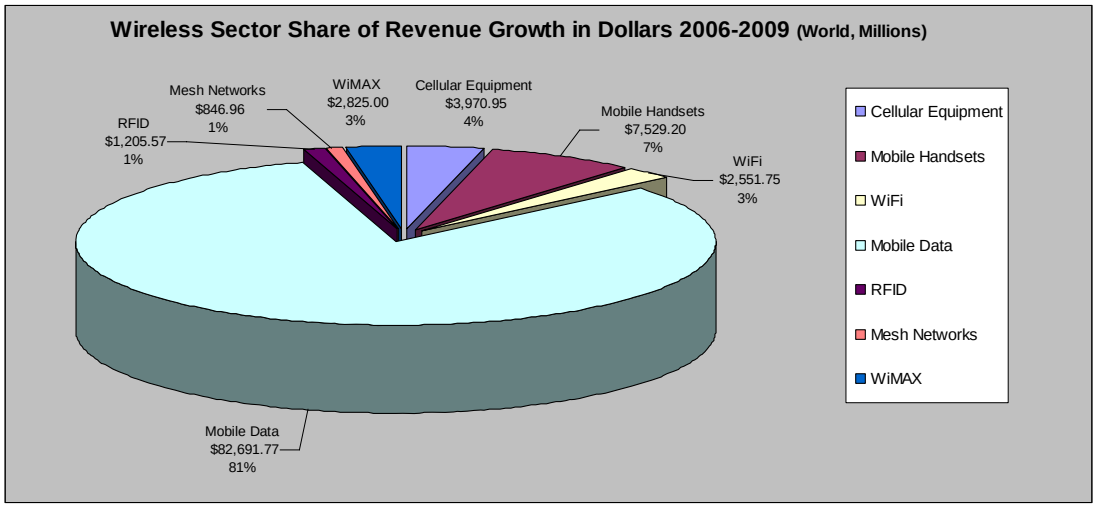


Figure 75 — Wireless Sector Share of Revenue Growth in Dollars 2006-09[107]

IP Infrastructure and Service Enablers

With the evolution of cellular networks towards packet switched data and enhanced bandwidth, the market for IP infrastructure and service enablers will grow. There are a lot of Canadian companies that are present in this space who have a vast array of products that they are successfully exporting to multiple regions around the world.

On the IMS side, Nortel has an IMS solution that is currently being trialed by Verizon in the US. In a recent survey by KAZAM Nortel's IMS solution was classified as strong by a select few North American and European operators. Some operators classified Ericsson and Lucent as leaders in this market segment. Convedia is a Canadian company that offers IP-based multimedia servers and has been successful in selling its products to operators in different regions around the world, including China Mobile, China Unicom and Telefonica.

Airwide Solutions offers service enablers for messaging and has sold to over 70 operators, including Vodafone, in 46 countries around the world. Redknee is another Canadian company that has enjoyed success internationally and has products that are prevalent in the European markets with operators such as Vodafone, O2, Orange and E-plus.

Eastern Europe and MEA will be the two biggest growth regions in the world over the next few years and will offer the greatest opportunity to Canadian Companies looking to gain market share in the cellular equipment market.

[107] KAZAM Wireless Sector Revenue Forecasts, 2006. The dollar amount represents the change in revenues for the sector from 2006–09, the percentage is the share of the total change across the entire wireless industry.

Emerging markets looking to leapfrog wireless technology generations also present tremendous opportunity as they look to catch up to the developed world.

WiFi Mesh Networks

WiFi Mesh Networks differ from WiMAX networks in that WiFi-based Mesh Networks utilize the highly pervasive 802.11 standard. WiFi CPE devices are easily available and inexpensive, and are typically operated in the unlicensed frequency band. In the case of a wireless mesh network however, one requires a mesh of multiple base-stations inter-connected to provide coverage equivalent to a single WiMAX base-station. Canada has strengths in this sector of the wireless industry. BelAir Networks has been at the forefront of the development process of WiFi based Mesh Networks. Canadian companies in this space have started to sell their products in the highly competitive US market where they face stiff competition from the likes of Tropos Networks and Strix Systems. Tranzeo Wireless Technologies Inc is another Canadian company involved in WiFi Mesh Networks, which offers solutions in the 2.4GHz and 5.8GHz range. Tranzeo has a strong presence in this market because of their extensive dealer and distributor network, which covers every region around the world with particular emphasis on the North American market.

The market for Mesh Networks is expected to grow by a CAGR of 96 percent to $976M in 2009 (see Figures 76 and 77)[108]. Given that Mesh Networks and WiMAX are competing technologies, KAZAM expects the growth of Mesh Networks in the different regions around the world to match that of WiMAX. It is important to note however, that the market for WiFi Mesh Networks is much smaller than the WiMAX market. As an example, WiMAX revenues in 2009 are expected to exceed $3B, while WiFi mesh revenues will stay under $1B in 2009 (see Figure 77).[109]

[108] Source: In-Stat Market Alert: *Wireless Mesh Network Equipment Market Accelerates*, October 2005, http://www.instat.com/newmk.asp?ID=1462.

[109] Sources: In-Stat Market Alert: *Wireless Mesh Network Equipment Market Accelerates*, October 2005, http://www.instat.com/newmk.asp?ID=1462. IDATE: *WiMAX – Ready for deployment*? September 2005, http://www.idate.fr/pages/index.php?rubrique=etude&idr=16&idp=104&idl=7.

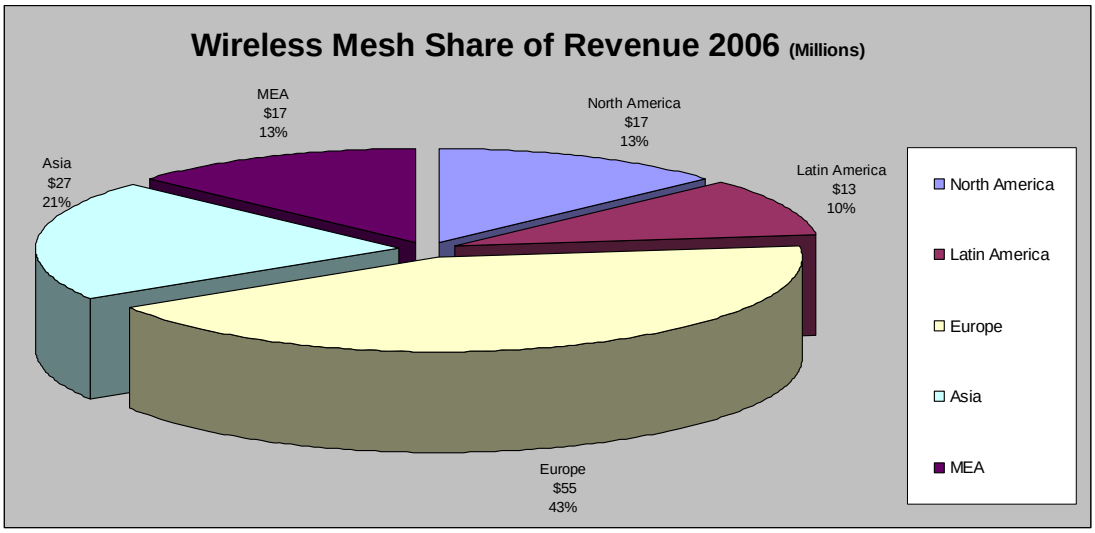


Figure 76 — Wireless Mesh Share of Revenues 2006[110]

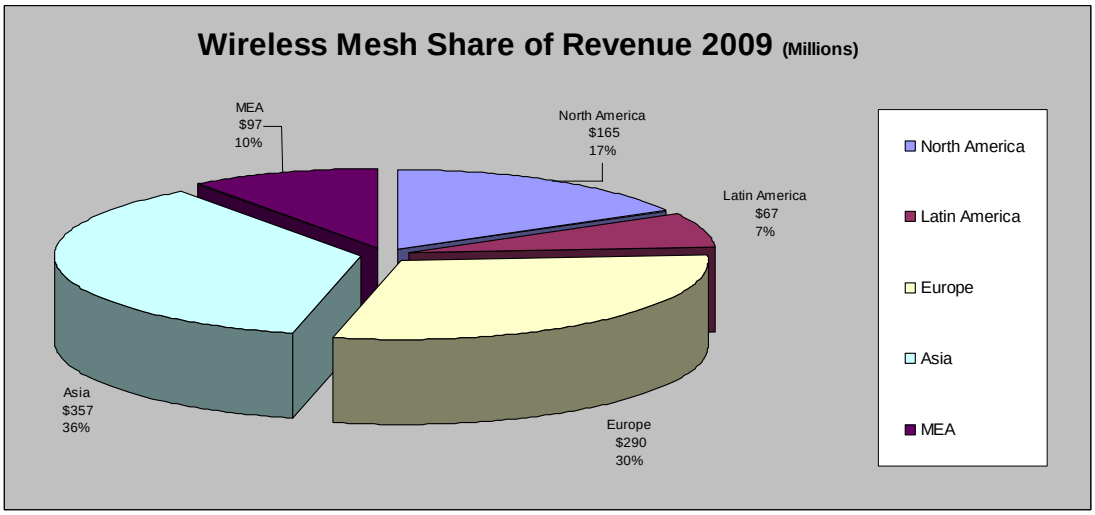


Figure 77 — Wireless Mesh Share of Revenues 2009[110]

Semiconductors

Canada has several players in this sub-sector of the wireless industry value chain. Companies such as SiGe Semiconductor that develops chipsets for use in cellular handsets, WiFi equipment and Bluetooth enabled devices. SiGe has also established offices in Hong Kong and UK along with the US to facilitate the sale of its products in the different regions of the world. SIGPRO Wireless is another company that develops chipsets for use in cellular infrastructure and handsets. ATI Technologies' a leading developer of chipsets for enhancing video capability on mobile handsets.

[110] KAZAM Wireless Mesh Forecasts, 2006.

The world semiconductor market is expected to continue growing as new wireless technologies such as WiMAX, UWB, and wireless mesh enter the mainstream market. The sheer size and growth in the cellular device market represents a tremendous area of opportunity for Canadian companies in this space.

Strength in Professional Services

Companies in Canada have put a lot of effort into differentiation through superior best practices for technology and product development, sales, customer care and branding. Canadian companies such as SaskTel International, TELUS International, CGI, and Psion Teklogix, McCarthy Tétrault, and KAZAM Technologies provide professional services to firms in the US and elsewhere.

- Sasktel International is successfully establishing itself in global markets, supporting operators via transformational and network deployment services. Sasktel is considered to be an innovator and an early adopter of technologies. It became one of the first to launch VoDSL (Video over DSL), EVDO services, and WiMAX deployments through its investment in Navigata.

- TELUS International is a subsidiary of Canadian operator TELUS. It provides innovative IT and IP based solutions, customer care and call centre services, across many geographic regions. It has extensive infrastructure already in place in many key international markets.

- KAZAM Technologies is a provider of management consulting, applied strategy and tactical planning services specializing in wireless and broadband communications. It has supported operators and vendors from Canada to South Korea and assists several Canadian firms in building international market entry plans, as well as helps international companies enter the North American markets.

- CGI delivers end-to-end IT and business process services with 25 000 professionals serving clients around the globe. It also provides cost-effective and flexible delivery capabilities to customers.

- McCarthy Tétrault is a Canadian law firm providing, among other services, technology law and regulatory guidance to companies and governments all over the world. The firm advises on many of the largest transactions and cases. Authoritative legal directories such as the *International Financial Law Review* and Lexpert's *Guide to the Leading 500 Lawyers in Canada* consistently rank McCarthy Tétrault among the world's top law firms.

Key Developing Areas and Global Potential

Canada's R&D capability, access to skilled technical talent and human resource indices all point to strength in its ability to produce innovative technological solutions and products. The following represent areas where Canadian companies are developing quickly and demonstrating potential:

1. Mobile Content Development and Marketing
2. RFID Products
3. Cellular Services Industry
    - Cellular penetration rates
    - Persistent fast follower approach
    - Impact on Canadian SMEs
    - Monetization of technology investment
    - Handset subsidies and service adoption
    - Competitive pressures expected to grow

Mobile Content

KAZAM believes that the world mobile content market will grow at a CAGR of approximately 20 percent from 2006–09. The global mobile content industry is expected to be worth around $110B in 2006 and grow to over $190B by 2009.[111]

Canadian companies have several strengths in the mobile content industry with companies like Airborne Entertainment, MyThum Interactive, Tira Wireless, VoCoMo and OZ Communications to name a few. For instance, Airborne in partnership with Tira Wireless is publishing content for and bringing to market powerful brands like 20th Century Fox, HBO and World Wrestling Entertainment (WWE). MyThum has enjoyed success in developing innovative solutions such as short codes and mobile marketing to enhance interactivity of mobile content. VoCoMo has a mobile dating platform that is being used in the Canadian, US and UK markets. OZ Communications has developed solutions for mobile IM and email that are being adopted by operators internationally.

Canadian content providers are in the unique position of being able to develop content to cater not just to the Anglophone regions but also to the Francophone regions around the world. In our interview of vendors, KAZAM learned that French-speaking Canadian artists are quite popular in Francophone countries around the world. This creates opportunities for Canadian content companies to leverage Canadian artists and develop mobile content for export to these markets.

[111] KAZAM Mobile Data Forecasts, 2006.

Despite all the strengths, mobile content remains an area of opportunity for development. With a market worth billions globally, mobile content can become a lucrative area for Canadian companies.

The mobile content value chain at its most basic level consists of three key participants: content providers such as media companies, music labels etc.; content developers, publishers and aggregators; and operators or service providers. Additionally, the regulatory environment can impact the mobile content industry. To create an ideal ecosystem for mobile content all three players need to collaborate and drive the industry forward, and the regulatory environment needs to be conducive for innovation, adoption and growth. Markets with successful mobile data services have all shown a great degree of collaboration, including agreeing on mutually profitable revenue share arrangements.

Most Canadian mobile content companies have limited their focus to the US market due to cultural similarities, close proximity and cost of business development. Canadian companies are rightfully focusing on the US mobile data market, which is forecasted to be worth over $10B by the end of 2006 and grow to under $30B in the next three years.[111] However, they are losing out on the opportunities internationally by failing to capture market share in the rest of world's projected $160B mobile content market for 2009 (see Figure 79).

Canadian companies are strong in publishing content and content aggregation. However, they face challenges in creating mobile content, branding and marketing it to overseas markets. For the Canadian mobile content industry to move forward and grow, these challenges will have to be addressed.

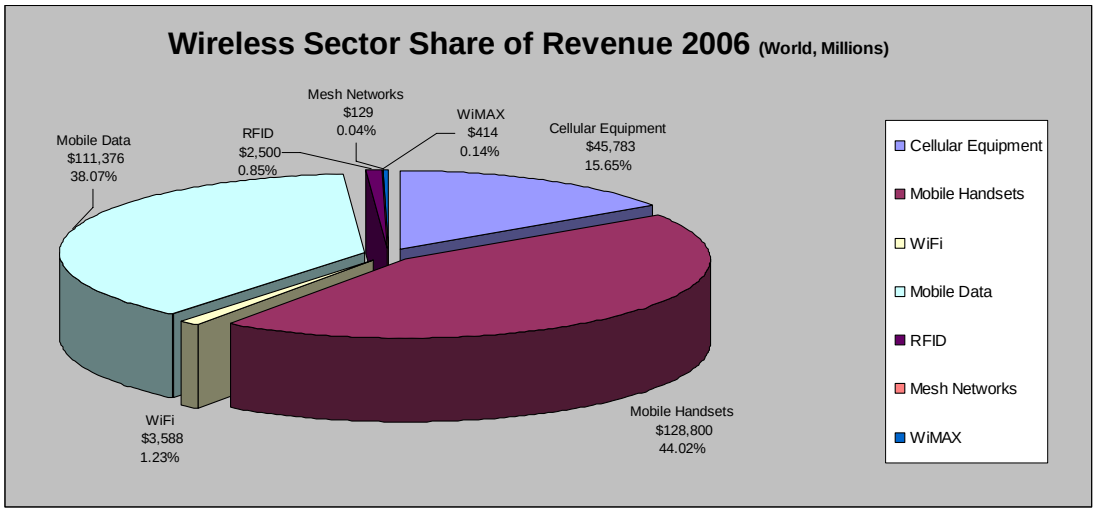


Figure 78 —Wireless Sector Share of Revenue 2006[106]

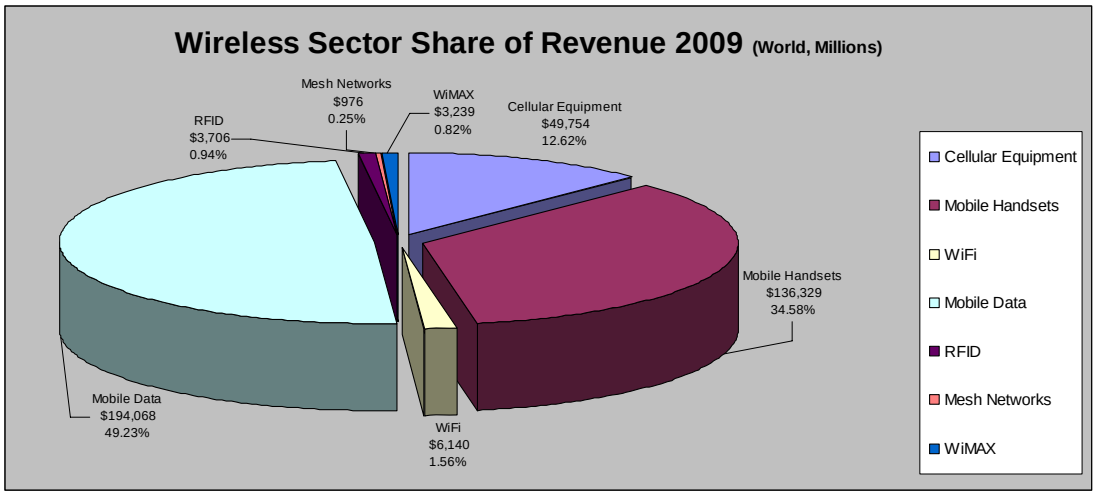


Figure 79 — Wireless Sector Share of Revenue 2009[106]

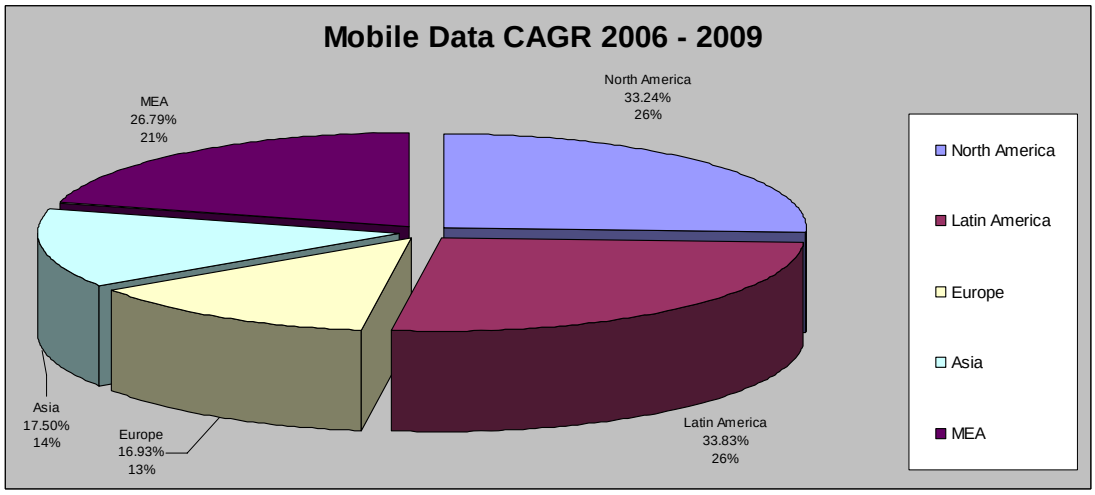


Figure 80 — Mobile Data CAGR 2006–09[111]

RFID

With the exception of a few companies such Psion Teklogix and what was formerly eXI Wireless (bought out by VeriChip Corporation), Canadian companies face challenges in RFID. With the establishment of the Canadian RFID Centre in Markham, Ontario and the participation of key players such as EPCglobal, IBM, Intermec Technologies Corporation and Symbol Technologies development work among Canadian companies is expected to pick up.

The purpose of the Canadian RFID Centre is to bring together the different players in the RFID value chain and help with the development of RFID solutions with the primary focus being the logistics and supply chain industry. The $1.7M facility is among the first in North America to demonstrate the use of Gen 2 RFID tags as specified by EPCglobal. The development centre will help Canadian companies understand and test out their Gen 2 compliant RFID products be it tags or readers.

The world's RFID market for tags and readers is expected to grow at a CAGR of over 15 percent between 2006–09 (see Figures 81 and 82).[112] The largest market opportunity will be in North America, Europe and Asia-Pacific. Initially, the US market will present the largest market opportunity driven by the US Department of Defense and retailers like Wal-Mart and Proctor & Gamble in collaboration with the EPCglobal consortium.

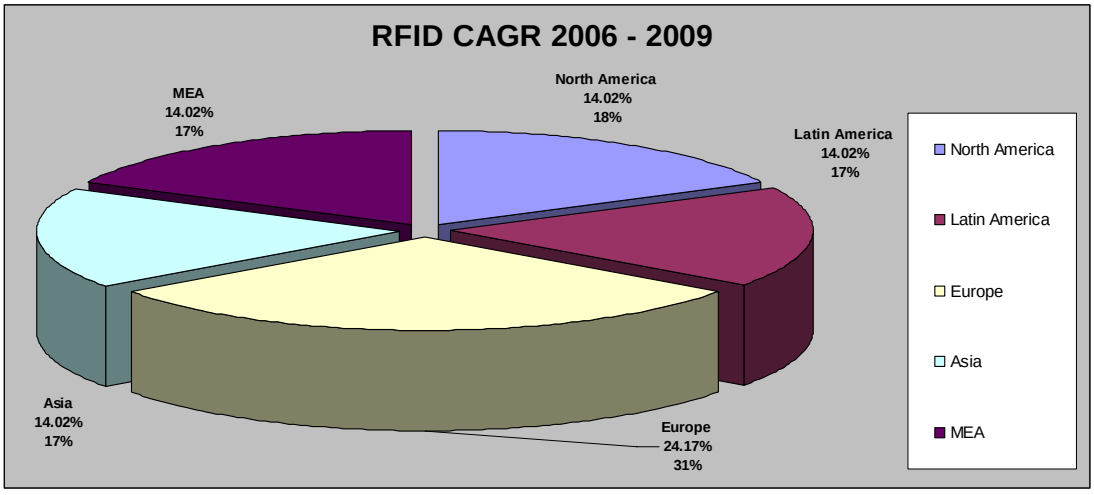


Figure 81 — RFID CAGR 2006–09[112]

[112] KAZAM RFID Forecasts, 2006.

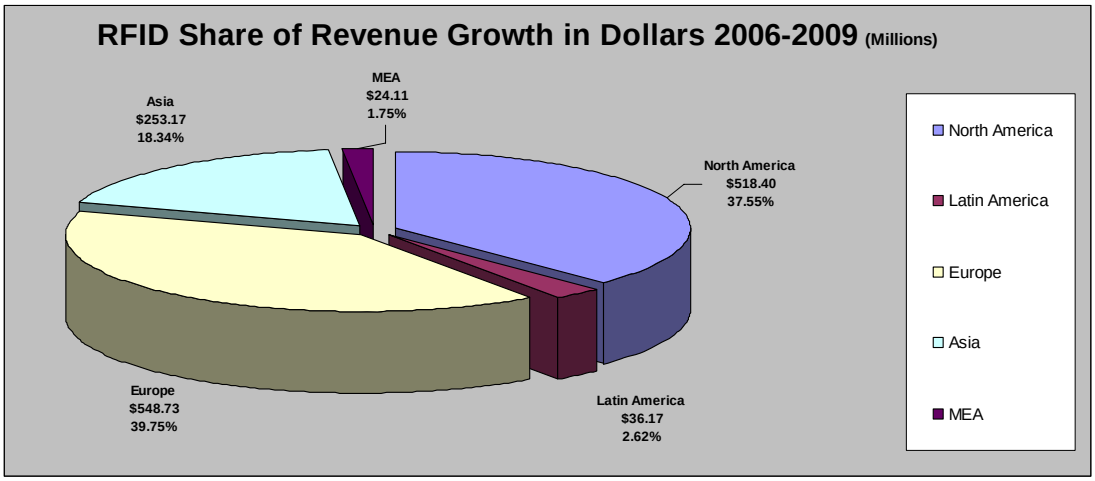


Figure 82 — RFID Share of Revenue Growth in Dollars 2006–09[112]

The Cellular Services Industry

According to Wireless Intelligence,[113] the North American cellular services industry has outperformed all regions of the world for ARPU since 2002. The average North American APRU is over 1.4 times that of its closest rival, Western Europe, and over 2.5 times that of most other regions in the world.

The Canadian cellular services industry exhibits strong business and financial performance indicators. Canadian operators represent a strong ARPU position in North America. While global ARPU has declined on average by over 27 percent between 2002–05,[113] the year over year ARPU in Canada increased by 4.6 percent for Q4 2005.[114] In this same period, US average ARPU declined by 2.5 percent (see Figure 83).[114] Canadian ARPU from data services represents 8.5 percent of the overall ARPU according to Merrill Lynch.[114] According to the same report, churn in Canada is on average at 1.6 percent, while the US average churn is 2.1 percent for this same period. In a report issued in 2004 by N. Moore[115], the Canadian cellular services industry faired well across multiple categories that included churn, customer satisfaction, and ARPU. In fact, TELUS Mobility was ranked number one on the list among North American operators. Despite the large Canadian geography and significantly lower population than the US, Canadian operators have demonstrated exceptionally high financial performance, with EBITDA margins in excess of 41 percent on average, representing EBITDA margins that are on average 33 percent greater than those of US operators. This

[113] Source: OVUM, *Global ARPU: the pressure is on*, March 2006. Weighted Average World ARPU; Weighted Average Regional ARPU; CAGR in ARPU.

[114] Source: Global Wireless Matrix 3Q 2005, Merrill Lynch, December 22, 2005.

[115] Source: N. Moore Capital Limited NY 2004.

indicates a financially strong cellular services industry that has outperformed North American metrics despite a large geography and a relatively small population.

While operators have worked hard to achieve this distinction, the Canadian cellular industry has challenges. We focus on the cellular industry as it represents by far, the largest part of the Canadian wireless ecosystem. Some of these challenges are listed below:

Cellular Penetration Rates

The Canadian wireless penetration rates[116] are among the lowest in developed countries, lagging behind the US, all of Western Europe, most of Asia Pacific and some parts of MEA. While one may think of several reasons for this, the cost of cellular services in Canada combined with attractive wireline plans play an important role.

According to a recent study by Merrill Lynch,[114] the average ARPU in Canada is $48 vs. $56 in the US.[117] US subscribers avail twice the number of minutes on average per month, relative to Canadian subscribers (US minutes of use: 781 vs. Canadian minutes of use: 393). This yields an effective cost of $0.11 cents per minute for Canadian subscribers, vs. $0.07 cents per minute for US subscribers. On a per minute basis, as an average, Canadians are paying 57 percent more than US counterparts.

[116] An important note to consider when looking at global penetration rates, is that, most of the world is dominated by GSM with predominantly unlocked handsets, that allow users to own multiple SIM cards. Some penetration numbers do not take this factor into account, and therefore, for several parts of the world, the effective subscriber penetration rates are likely lower than believed. In Canada, CDMA is the dominant technology, so the question of multiple SIMs doesn't exist, however, even GSM phones are locked by default, requiring customers to have them unlocked to use SIMs from other operators when roaming, thereby creating a barrier to multiple SIM card ownership. This results in a more accurate estimate for Canadian penetration rates, but makes them less attractive than they may actually be, relative to the rest of the world.

[117] Merrill Lynch does not use purchasing power parity to do this comparison, however, given the current exchange rate, the difference would be nominal.

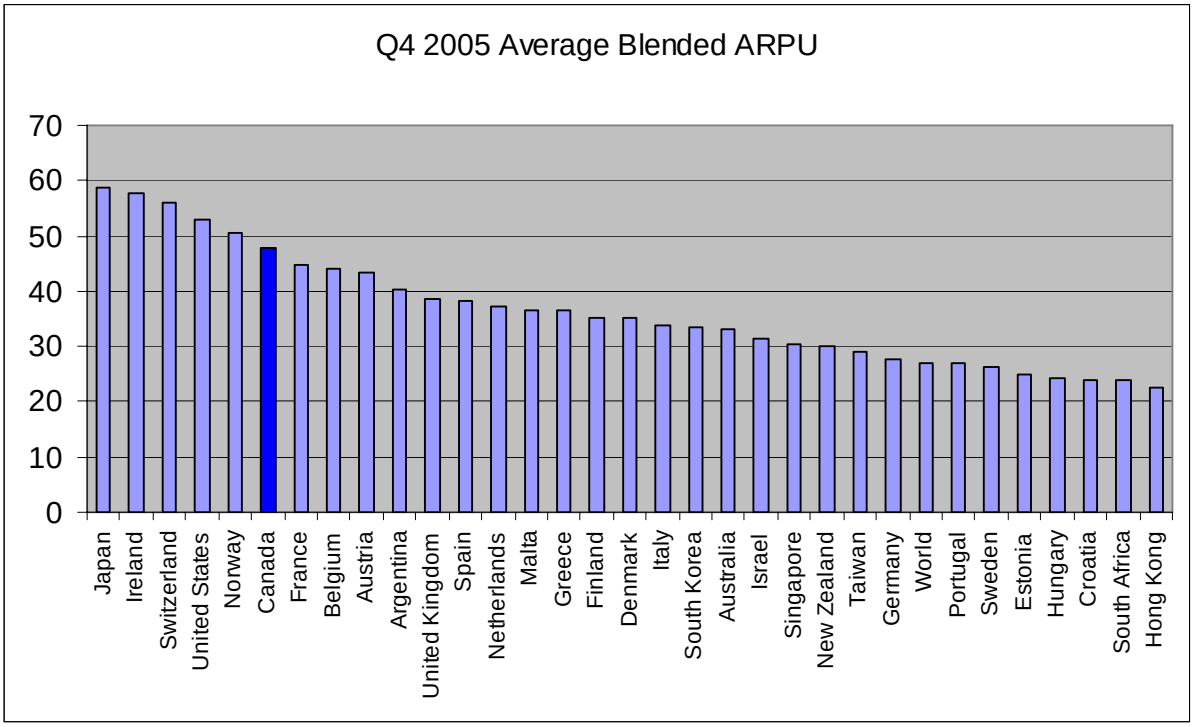


Figure 83 – Average blended ARPU for cellular providers, includes pre and post paid customer revenues, Wireless Intelligence, Q4 2005

A study by the OECD[118] suggests that Canada is highly competitive for average usage plans among OECD countries, but not as attractive for high end users. The OECD study is from 2004 and is influenced by business models found outside of North America, where "calling party pays" is prevalent. This makes the comparison of North American rate plans to those of Europe and other parts of the world more challenging, as in North America, the called party also usually pays. Another limitation of the OECD study is that it only compares a single Canadian rate plan to a single US rate plan. In this example, there were key differences between the plans that were not considered,[119] especially features such as caller ID and voicemail. The OECD study finds that Canada is more expensive for low and high usage customers, but somewhat cheaper for medium users. In KAZAM's opinion, it would be beneficial to compare Canadian plans to US plans, however, the comparison should also take into account the overall quality of service, customer care, and customer support provided to customers, rather than just pricing. This is relevant as a customer pays for more than just voice minutes when deciding on what rate plan to select. Until late 2004, and into 2005, the US market has been overly competitive with up to seven competitors per market, resulting in

[118] Source: OECD: *OECD Communications Outlook, 2005*: http://www.thepublicvoice.org/events/tunis05/oecd_outlook.pdf.

[119] As an example, in a comparison between US and Canadian rates, the OECD study failed to take into account three additional features in the base US plan, in addition to over 40 percent more minutes included in the US plan, relative to the Canadian rate plan.

rapidly downward spiraling rates. The market in the US has since undergone consolidation with four major competitors in a given market.

Higher costs per minute for cellular services, and relatively attractive wireline service rates contribute to the shortfall of penetration rates in Canada vs. those of the US. While it may not be conducive, given the Canadian economies of scale, to price services in Canada at US rates, there is room for more competitive pricing in Canada — especially for high end rate plans, with long term contracts, where subscribers use features such as voicemail, caller ID and messaging.

Persistent Smart Follower Approach for New Technology Introduction

While Canada has led the North American market (ahead of the US) in broadband and wireline services, it tends to lag the US and most developed countries in bringing wireless technologies to market and effectively developing creative services, and then promoting them to consumers. Canada lags behind the mature markets of Japan and South Korea by 18 to 24 months (or even longer in some cases) in launching new technologies and products, and in bringing value-added services to market.

The business rationale for this lag is often the scale of the Canadian market. Operators and enterprises tend to wait until new technologies have reached a market inflection point, where economies of scale make it possible for them to deploy new services. However, there are examples of several similar or smaller countries that have lower GDP per capita (considering purchasing power parity), that lead Canada in deploying new services and bringing new products to market faster. Examples of these countries include South Korea, Singapore and Finland to name a few.

While a smart follower strategy often makes business sense, when used consistently across the board by a large number of participants (i.e. all operators), it does tend to slow down the adoption, trial, and commercialization of technology in the local market. When this becomes the rule, and little to no risk is taken by operators in deploying new products and services, then the impact on the overall wireless value chain can be significant, especially as the cellular industry in Canada is by far the largest part of the wireless ecosystem. The fact that cellular operators are at the end of the value chain causes a ripple effect for vendors providing applications and content, service enablers, infrastructure and so on to operators. These local vendors must now look to international markets wherein to trial and commercialize their products, and for the large majority of Canadian SMEs this is a challenge.

Impact on Canadian SMEs

The vast majority of Canadian wireless innovation companies tend to be SMEs. The "smart follower" approach of the local market results in some local innovation companies relying on foreign markets for opportunities to commercialize leading edge products. The resources (people, time and investment) required to become established in international markets, coupled with the lack of international business experience, and often the lack of a local reference client, presents challenges for an SME. This can limit their ability to tap into large and emerging markets beyond the US (i.e. BRIC countries), which require local presence, have long sales cycles, and will sometimes have political, technical, and business preferences that create barriers to entry.

Slow to Fully Monetize Technology Investments

A challenge that is perhaps even more impacting to the Canadian value chain than the smart follower approach is that the Canadian cellular industry is slow to fully monetize the technology investment when it is made. While the business case for some services just doesn't pan out, and sometimes waiting for economies of scale makes the most business sense, when it comes to innovative service development and creating marketing wrappers around the basic technical capabilities of a service, the Canadian cellular industry tends to lag most developed and mature markets. For instance, while we led North America with the launch of inter-carrier SMS (as well as MMS and short codes), and while SMS usage has been growing exponentially in Canada, the focus has been on text messaging, and premium SMS content and other value-added messaging services have been slow to come. In cases where such services do exist, such as short codes, market education is lacking. Therefore, there is still considerable opportunity available for operators and solution providers to add revenue streams and to fully monetize existing platforms for messaging (SMS, MMS).

Elements that impact full monetization, include the dynamics of the Canadian ecosystem for content and applications, where operators, content providers, and regulatory conditions play a part. Market activity and adoption can also be improved through things like a balanced approach when it comes to allowing off portal access to users for access to content (vs. a walled garden approach), simplicity in pricing, and a compelling end use experience for data services.

There are several signs of positive change within the cellular industry. The emergence of new MVNOs has been positive for consumers. We are starting to experience the beginnings of real change where convergence, segmentation, and value-added data services are picking up. Mobile VoIP, integrated cellular-WiFi, MVNOs and municipal wireless deployments will eventually lead to a higher degree of competition and activity in the market.

Balancing Handset Subsidies with Service Adoption

It is important to mention that, due to their relatively small size when compared to US operators, Canadian operators face a key challenge in acquiring handsets. Their size limits the number of handsets they order, and the reduced volumes result in either acquiring handsets that were mass produced for larger operators or paying a premium for them over their larger counterparts in the US. Handset subsidies are a key part of the overall cost of acquisition (COA) for operators. The Canadian COA numbers are second to Mexico in the world, and over 75 percent higher on average than those in the US (see Figure 84). As a result, handset subsidies impact Canadian operators significantly. Over 60 percent of operators surveyed, as part a sample of over 1000 industry respondents, say that handset subsidies will go down or stay flat in 2006.[120] Operators are faced with the difficult dilemma of reducing handset subsidies (to offset their cost of doing business) vs. driving adoption of new services, such as Mobile TV, that require users to upgrade handsets. One benefit Canadian operators derive from handset subsidies is the relative control they have for locking devices and the length of contracts.

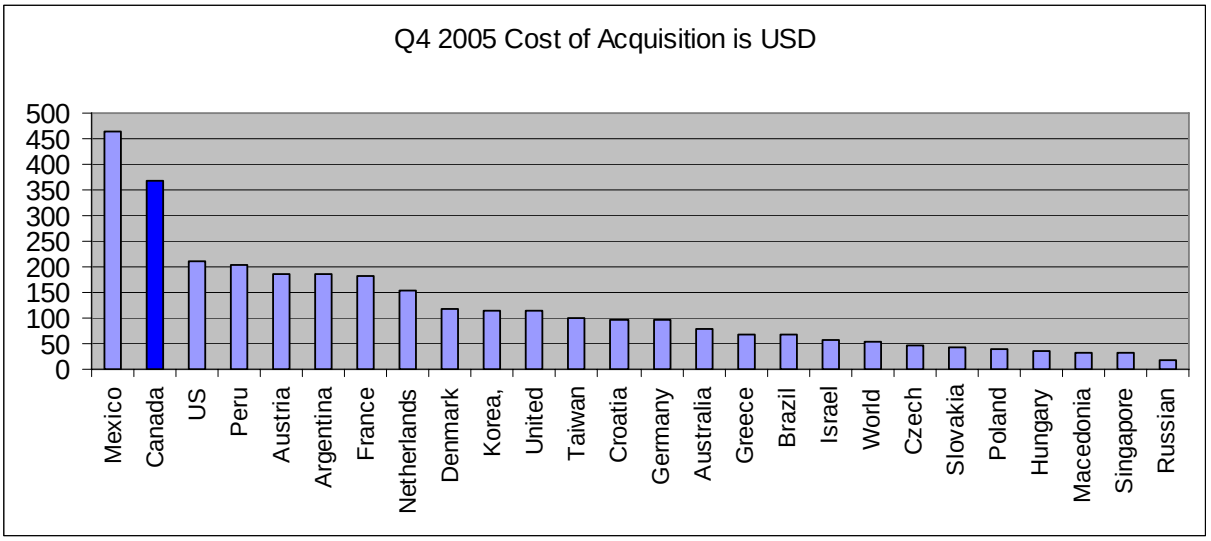


Figure 84 — Cost of acquisition for cellular service providers, includes equipment costs, trade commissions, net of related revenue for new customers only, Wireless Intelligence, Q4 2005.

[120] Source: Informa Telecoms & Media, *Annual Mobile Industry Outlook 2006*.

Competitive Pressures Expected to Grow

The cellular industry in Canada seems to be lagging mature markets in Asia-Pacific, Western Europe, and to a lesser degree the US, when it comes to looking for innovative ways to build additional revenue streams outside of voice. Operators have been traditionally slow in fully monetizing the technology investments made by aggressively bringing creative and innovative value-add services to market.

The Canadian cellular services ecosystem is behind many developed markets in some key areas of note in the industry. This includes the lack of wireless number portability (WNP) in the Canadian market. According to a submission to the Canadian Radio-television and Telecommunications Commission (CRTC) by the CWTA,[121] Canadian operators voluntarily offered to support WNP as recognition of the service enhancement it offered consumers. The submission indicates that the length it took some countries from their initial consultation to launch ranged between 2 and 7 years. Hong Kong started the process in 1997 and completed it within 2 years, whereas the US took the longest at 7 years.

Pioneering countries that first tackled wireless number portability, worked with equipment vendors to have WNP functionality supported, and tested inter-carrier issues while porting for the first time. As a result, it took longer to implement WNP in the early days. Given that most vendors support WNP functionality and that lessons on successful implementation of WNP have been learned in the industry, it should be a faster process today. The Canadian approach to number portability is to do a complete three way inter-modal number portability (wireless to wireless, wireless-to-wireline and wireline-to-wireless) from day one. This approach is more complex than just wireless-to-wireless number portability, and one would expect that this results in a longer time to implement and test, than just implementing WNP alone. While there is a debate as to whether number portability will really mean much in terms of net churn, it does allow subscribers to switch operators if dissatisfied and retain their number, thereby adding an element of fair competition. The sooner that this can be done, the better it is for consumers.

Anything driving competition will help to invigorate the end-to-end wireless ecosystem. An active and highly competitive cellular market helps other participants in the value chain and improves the overall ability of Canadian wireless participants to compete internationally.

With the entrance of disruptive technologies and new business models including wireless mesh, WiFi, WiMAX, Metropolitan Area networks, VoIP over WiFi,

[121] Source: CWTA Comments on Public Notice CRTC PN 2004-14, dated October 6, 2005.

MVNOs, municipalities and branded companies such as Virgin, changes in the level of competitive pressure can be expected. Traditional billing models and bundling strategies will have to adapt and respond to the new competition, or they will become outmoded. It is hard to say when these changes may take place. When they do, they will likely begin in niche markets and larger metropolitan areas over the next few years.

Key Areas of Weakness and Global Potential

Export Capability

The majority of Canadian innovation companies are SMEs in every sector, particularly in the wireless sector. The relatively small size of the Canadian market and overall slowness to adopt new technologies, results in some local innovation companies relying on foreign markets for opportunities to commercialize leading edge products. The resources (people, time and investment) required to become established in international markets, coupled with a potential lack of international business experience, and often the lack of a local reference client, presents challenges for an SME. This limits their ability to tap into large and emerging markets beyond the US (i.e. BRIC countries), which require local presence, have long sales cycles, and will sometimes have political, technical and business preferences that create barriers to entry.

The average size of Canadian innovation companies is not likely to change but creation of local deployment opportunities, support for international development via joint ventures, trade missions etc, and support for business process improvement and commercialization in the home market are likely to enhance and improve exports. The creation of local deployment opportunities relies, not only on available funding but also on the foresight and sophistication of managers and decision makers. According to the Institute for Competitiveness and Prosperity, 31 percent of Canadian managers have a bachelor degree or better vs. 50 percent in the US. (See Figure 98) This suggests that investment and incentives to promote advanced education among Canadian managers can have a positive effect on local deployments of advanced technologies, supporting and driving innovation to the export level. Canadian tax incentives are of the most generous in the world but they are "hard science" focused and do not support business process improvement and commercialization. A shift in the focus of these funds towards business process improvement, commercialization and advanced training of managers has the potential to enhance technology exports significantly.

Comparison: Canada, US and South Korea

While it is valuable to compare Canada to the US (a market 10 times our size), one often uses the size to explain away the disparity in our ability to compete or in our ability to bring products and services to market (including our ability to export). Therefore, we look to another market that is proportionately closer to Canada in terms of size, but is considered a world leader when it comes to many facets of wireless. This is the South Korean market with a population size approximately 1.3 times that of Canada. It is important when noting areas for improvement to look at a world leader rather than another mediocre or similar performing market. South Korea is similar in that it is not much larger than Canada, produces 30 percent less GDP per capita, sits at the doorstep of two very

large markets, Japan and China, yet it is the leading exporter of technology, services and devices. When examining South Korea's rating for technological activity, human capital and access to capital indices with Canada's, Canada should be ahead of South Korea or at least on par with our level of innovation output and our world position. This is not the case and we will compare South Korea and Canada in greater detail in later sections.

The South Korean market is considered to be the leader across most wireless sectors (Cellular, WMAN, mobile broadcast, devices, services, content and applications, branded portals, etc.). It however, lags Canada in several areas including access to capital for investment and innovation, amount of technological activity and human development.[122] Thus from an R&D and innovation perspective Canadian and South Korean firms should be at par. While this is true in many instances of innovation, the marked difference is in the following two areas:

- the South Korean wireless industry's ability to be first to market in launching new technologies, products, and services locally; and
- the superior strength of South Korean companies to export products internationally.[123]

While the wireless industry in South Korea is challenged with similar size and scale issues as Canada (other than for handset acquisition, which is a major advantage Korean operators have as a result of indigenous strength), the South Korean wireless industry tends to be one of the earliest to launch new products and value add services in the world. Sometimes this is as a result of regulation, but often this is for competitive and strategic reasons.

As an example, the South Korean government issued WCDMA licenses in 2002 to KTF and SKT, while requiring both mobile phone manufacturers to produce handsets that work on both CDMA and WCDMA standards. KAZAM believes that WCDMA was prematurely mandated to provide a hedge against the rivalry between the traditional GSM (WCDMA) and traditional CDMA (IS95, CDMA2000) camps. South Korean vendors have traditionally led the CDMA market, but haven't really participated in the much larger GSM market. Arguably, this allowed Korean vendors to build, test and commercialize WCDMA (3GSM) products, realizing that WCDMA (3GSM) may eventually support up to 80 percent of the world subscriber base. While, this seemingly pre-mature push towards WCDMA by the South Korean government will position Korean manufacturers to support the demand for WCDMA, initially, like Japan, the

[122] Capital Access Index: Canada at 123% vs. South Korea at 105% (US 128%), Technological Activity Index: Canada at 132% vs. South Korea at 119% (US at 139%), Human Development Index: Canada 114% vs. South Korea at 108% (US at 113%), Growth Competitive Index: Canada 110% — same as Korea (US at 126%).

[123] High-tech exports for Canada are US$23B vs. South Korea are US$57B (US at $160B). Source: World Bank, *World Indicators* 2005.

WCDMA experience of SKT and KTF was poor. However, there is hope that like Japan there are signs of growth in WCDMA in South Korea. A potential lesson to be learned here is that the regulatory and policy making forces do have the ability to push operators forward, sometimes creating short term challenges but in the long term, creating competitive potential and stimulating the entire ecosystem value chain.

This example is meant to illustrate the extreme to which international markets will go to be able to export goods. While we're not proposing that operators and enterprises make unwise business decisions, the overly conservative approach of the Canadian market in adopting new technologies does hamper our ability to commercialize and export abroad. As the South Korean example shows, market size, access to capital, access to technology and skill sets, centers of innovative excellence in R&D are not the only determinants of success in the global commercialization of products.

Cellular Handsets

Despite Canada's leadership in data-centric mobile devices, the Canadian wireless sector is lagging in the cellular handset market. ATI Technologies is the only large-sized Canadian company with a market presence but it is limited to offering components such as video chipsets for mobile handsets.

Global handsets will grow at a CAGR of over 5 percent[124] between 2006 and 2009 however, KAZAM anticipates that the average handset prices will drop from approximately $140 to $126 driving down CAGR to approximately 2 percent.[124] The downward trend in handset prices will be a result of sub $50, and shortly sub $30 handsets hitting the market, with the majority of growth in new subscribers coming from emerging markets such as Brazil, Russia, India and China. The estimates take into account the counter balancing effect of subscribers in high penetration countries replacing handsets.

The majority of growth in the mobile handset market will come from the emerging markets around the world especially India and China, which are forecasted by KAZAM to form approximately a third of all cellular subscribers by 2009. The emergence of sub $50 handsets will also drive handset shipments in emerging markets whereas replacement sales will account for the handset demand in mature and developed markets.

The participation of Canadian companies in this space is best in the leveraging of Canada's R&D capacity for chipsets, SDR, and software clients for handsets. This is an area that can improve, if Canadian firm utilized the inherent strengths in each of the fore-mentioned sub-sectors to address the needs of the handset market.

[124] KAZAM Handset Forecasts, 2006.

Wireless LAN

The Canadian wireless industry's participation in the Wireless LAN (WiFi) products arena is relative small. There are a few Canadian companies such as Nortel and EION that can compete with WiFi market leaders such as Cisco (for access points) and Linksys (for CPE's). Even so, the focus of Canadian companies seems to be more on the enterprise and government side of the market rather than the consumer market.

Per KAZAM's forecasts the global WiFi Market is expected to grow at a CAGR of 20 percent between 2006 and 2009 and with global revenues $6B in 2009. (see Figure 85) With a market size this big, Canadian companies cannot afford to sit out of this lucrative market.

Canada is strong in R&D and Canadian companies can start developing products complying with the next version of WiFi i.e. 802.11n. The IEEE announced in January 2006 that the proposal draft for 802.11n had been confirmed and market leaders like Broadcom are already offering 802.11n compliant chipsets.

Growth wise, all regions around the world are expected to grow equally, however, North America, Europe and Asia-Pacific will represent the bulk of revenue growth in the next three years. WiFi revenues are expected to grow by 40 percent in North America, 30 percent in Europe and 25 percent in Asia-Pacific cumulatively representing growth of nearly $2.5B.[125](see Figure 86)

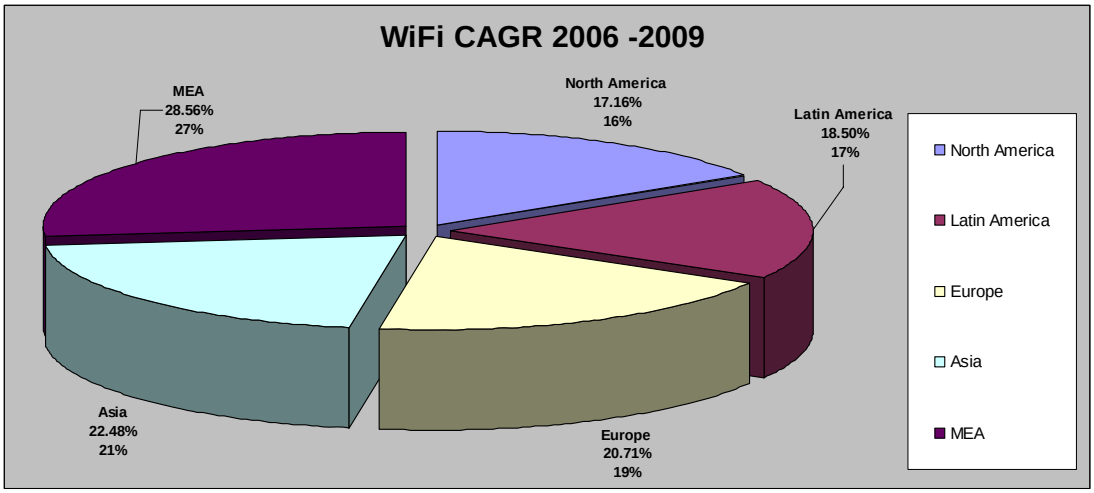


Figure 85 — WiFi CAGR 2006– 09[125]

[125] KAZAM WiFi Forecasts, 2006.

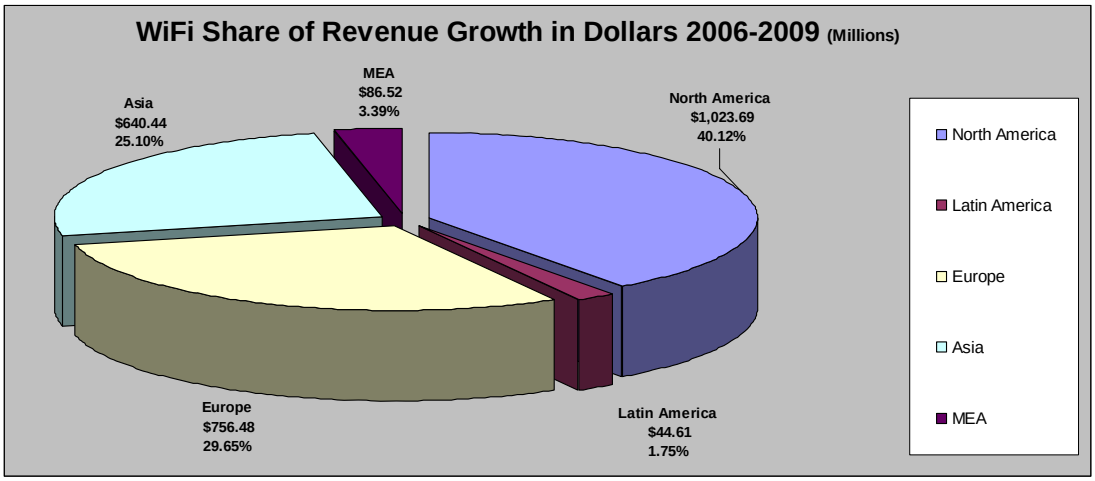


Figure 86 — WiFi Share of Revenue Growth in Dollars 2006–09[125]

Ultra Wideband (

Ultra Wideband (UWB) is an emerging technology, which is expected to replace USB, Bluetooth, Digital Video Input (DVI) and FireWire technologies. Two differing and powerful camps are emerging on the UWB standardization front namely WiMedia Alliance and the UWB Forum. A few UWB device manufacturers were demonstrating a wireless variation of USB at the Consumer Electronics Show (CES) in January 2006. Icron Technologies, which was also demonstrating at the CES and is part of the UWB Forum, was recognized for its UWB Wireless Hub. Despite the recognition, Canadian companies are weak in this subsector of the wireless industry. Given that the standardization and product certifications will take at least a year to complete, Canadian companies have the opportunity to partner with industry leaders such as Staccato Communications and Belkin to develop UWB compliant products.

West Technology Research revised its estimate for UWB shipments and predicted that Direct Sequence UWB (DS-UWB) component market would reach approximately half a billion by 2010.[126] DS-UWB is the variation of UWB being championed by the UWB Forum.

[126] TES News: TES to work on UWB solutions in collaboration with Freescale Semiconductor, November 2005: http://www.tesbv.com/04_051130.html.

Opportunities: Sectors and Regions

Opportunities for Canadian Companies: The US Market

The United States is Canada's largest trading partner as a result of proximity, similar business practices and overall social environment. This results in the majority of Canadian companies focusing on exporting products to the US. The US market is large, but also highly competitive, and the recent strength of the Canadian dollar has impacted our exports to the US. The US is also a single market, and the Canadian telecommunications environment is closely tied to it. When the US economy suffers, the impact on Canadian companies is significant. For the Canadian wireless industry to become successful in commercialization, it is critical for us to look beyond the US to markets where the majority of growth in wireless is taking place. This is difficult given the size of Canadian companies, as most wireless innovation companies in Canada are SMEs. The experience of Canadian SMEs in dealing with the US is significantly higher than the experience of SMEs in dealing with most emerging markets including Brazil, Russia, China, India, Pakistan, Argentina, Hungary, etc.

The US market will decrease for cellular infrastructure in the 2006–08 timeframe, whereas Europe, Middle East and Africa, South-east Asia, and Latin America will all grow (see Figure 87).

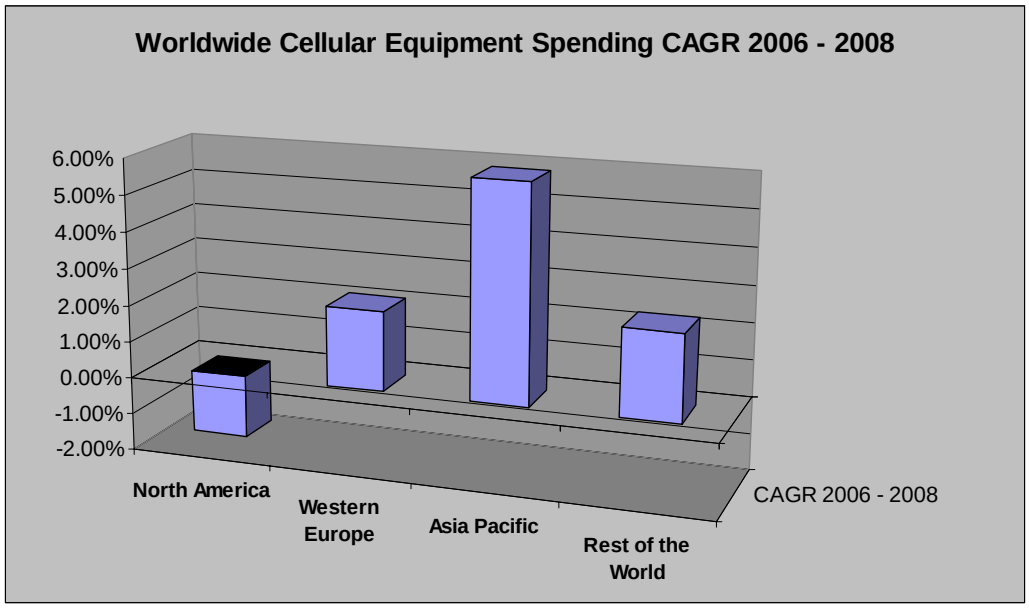


Figure 87 — Cellular Infrastructure Spending CAGR 2006–08[102]

For opportunities within the US, KAZAM would recommend that Canadian vendors continue to place more focus on the US market, than others for 3G and IP enablers, mobile content and RFID solutions.

While the cellular infrastructure market in the US is set to decline, this forecast includes spending on 2G technologies such as IS95, IS54, TDMA and iDEN. It is a given that spending in the US on these technologies will decline, while spending in the niche 3G infrastructure and data enabling IP technology investments grow. Canadian companies have leadership and strength in these areas and we should continue to leverage these for the US market.

The US market presents better opportunities for Canadian companies when it comes for mobile content and applications than for companies coming from Asia-Pacific and other parts of the world. This is due to the traditional links Canada shares with the US for entertainment, media services and content. Canadian content providers must exploit this relative advantage they have over those from other parts of the world, to enter the US market. Note that the majority of growth is coming from Asia-Pacific, Latin America and Western Europe for content services, and these markets would present a large opportunity. Unfortunately, as a combination of language and branding limitations of Canadian content, there may be some challenges in entering these markets. However, music and games can be generally treated as universal, and Canadian French content has a strong potential in several francophone countries around the world.

Opportunities for Canadian Companies: Emerging Markets

Great attention is being paid to the large emerging markets of Brazil, Russia, India and China. These markets are very large, are growing fast and every major player in the world has a focus on them. Despite this, few Canadian SMEs have deep enough pockets to take on the risk of local presence, and fewer have met with success.

In the Canadian wireless sector, most of the innovative companies are SMEs with limited resources. Local distributors and channels offer alternatives to local presence but relationships must be built and the tremendous size of these markets add the additional challenges of scale, which only a handful of companies can accommodate.[127] These challenges are in addition to the costs of travel and relationship building, the language and cultural differences and the associated business risks of a country. Needless to say, these markets do offer opportunities and Canadian SMEs should develop market entry strategies for them.

[127] For equipment, a base order may be far beyond the production capabilities of a SME. Nortel is one of the few Canadian companies that can handle the scale of supplying equipment to a market such as China.

The following represent emerging and newly developed markets that show high levels of potential opportunity and relatively lower business risk, costs and personal risk.[128]

Latin America

The first country considered in Latin America is always Brazil. At over 180 million people, Brazil is a very attractive market but to be fair, the risks must be considered as well. The level of corruption in Brazil is considered to be one of the highest, just ahead of Colombia, Peru and Venezuela. Approximately 22 percent of the population (or 36.2 million people)[129] is below the poverty line. To operate in this environment requires the establishment of local agents, local presence and secure relationships. In the past few years, Brazil has been undergoing heavy reforms and is improving, but a market like this presents a challenge to SMEs considering entry.

The telecom industry has been advancing quickly in Latin America. Although Argentina was hit economically very hard in 2001 (and as a result so were most countries in South America including Brazil), it is bouncing back very fast. Chile, a country that was shielded by the collapse of Argentina, has played a major role in the rebuilding of Argentina, particularly in the telecom space. There are many telecom companies that are operating in both markets and this region may prove to be one of the most advanced in the world for converged wireless/wireline services and broadband over powerline.

As per the KAZAM Technologies Business Security and Opportunity Index 2005, Chile, Argentina and Uruguay represent countries in Latin America that are similar to Canada in transparency, cost of doing business, crime, and size and offer opportunities for cellular equipment, enablers, applications and advanced value-added services.

Europe

Western Europe represents a tremendous opportunity for 3G equipment, data service and IP enablers, mobile applications and for content. It is also the highest growth area for RFID. As 3G networks expand, the need for value-added services and content will also grow.

The developing regions of Eastern Europe represent a strong opportunity for cellular equipment, enablers and WiFi Mesh with a high potential for WiMAX applications. Many North Eastern European countries are already saturated with multi-national players. South Eastern European countries such as Serbia-Montenegro, Slovenia, Romania, Macedonia, and Albania are in the process of rebuilding, of gaining membership in the EU and attempting to leapfrog into the 21st century by adopting the latest telecommunications technology. Macedonia has recently announced a plan to blanket the

[128] As evaluated on the KAZAM Technologies Business Security and Opportunity Index 2005.

[129] Source: CIA: *World Fact Book 2005*: https://www.cia.gov/cia/publications/factbook/.

country with WiFi mesh and Serbia is in the process of building their wireless telecommunications infrastructure from scratch.

These countries are geographically the size of a Canadian province, with approximately similar population sizes.

Middle East and Africa

The Middle East in general has been quickly deregulating and advancing over the last three years. Countries such as Kuwait, Oman, United Arab Emirates and Qatar, from a business and personal risk standpoint, and are relatively safe. These countries have been attracting the attention of large multi-nationals, many of who have established joint ventures and local presence in each market.

Libya has become a country of opportunity due to the recent lifting of sanctions by the US government. Libya is an oil rich country that is interested in building state-of-the-art networks throughout the country. It has requirements for cellular equipment, enablers, applications and operational expertise. It is a relatively small country but it is moving quickly to modernize, particularly in ICT.

Iran is a market that is over 80 million people, 15 million in Tehran alone. Until 2004, Iran had fewer that 400 000 subscribers to cellular services. This was not from lack of interest as there was a two-year waiting list for a SIM card that was priced at over $500 US and black market rates in excess of US$1500. Recent changes to regulations in that country have resulted in massive sales, estimated at over 6 million in the first four months of 2005.[130] Iranian officials have been negotiating with various multi-national companies and have recently signed an agreement with South Africa Telecom to augment and upgrade their national cellular network. Canadian companies have an opportunity with Iran as American companies cannot enter this market and Canada has a long-standing, good relationship with Iran.

Asia

Japan and South Korea represent the most advanced and mature cellular markets in the world. China and India represent the largest emerging markets in the world. Successful entry into these markets requires deep resources, patience and connections.

Pakistan, Indonesia and Bangladesh are fast growing emerging markets that are looking for alternative ways to meet the needs of their populations. One of the primary challenges of these markets is providing services and equipment at very low cost to large populations. This is a challenge that the GSMA Emerging Market Handset program is trying to address by working with manufacturers to jointly produce an ultra low cost

[130] Estimated from local Iranian news reports relayed to KAZAM.

handset. Due to the relatively low penetration rates of these countries, the suggestion is that there is an opportunity for cellular equipment and enablers. The population that is subscribed to cellular services is primarily prepaid, suggesting an opportunity to provide services and products that promote a post paid model.

WiMAX and Wireless Mesh could be strong solutions for the various issues in these markets, but as WiMAX is newly standardized, CPE and handset costs are high and will have to evolve down to a manageable cost. One of the solutions that is active in these countries is the "village phone" concept where an individual allows people to use a phone by the minute, and is often paid using the barter system.

The emerging markets of Asia represent non-traditional challenges for wireless companies but the rewards can be great for those willing to invest in innovative solutions.

Opportunities in Canada

Canada is a rich environment for R&D development, providing one of the most generous R&D tax incentive programs in the world. Canada's population is classed as highly educated, creative and diverse, scoring ninth in the world in UNCTAD's Human Capital Index, ahead of the US.

Canada supports the wireless industry through regionally centered wireless clusters and associations and government sponsored R&D centres and offers a high standard of living in both major centres and provincial areas. As Canada is a traditional and close trading partner of the US, ease of access to that market is unmatched.

Production facilities for content development, film development and creative development is world class as Canada plays host to a large percentage of Hollywood productions.

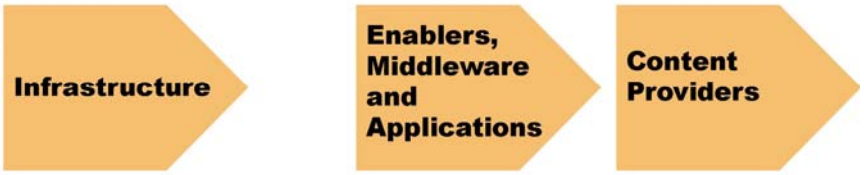
The Canadian population boasts one of the highest broadband penetration rates in the world, is technically savvy and open to new business models and technologies.

The presence of many multi-national R&D centres, including Ericsson's Canadian Centre of Excellence (the largest outside Sweden) and Siemens AG's Technology Innovation Centre, is proof of the innovation-supporting environment of Canada.

Wireless Value Chain: Key Sub-sectors & Players

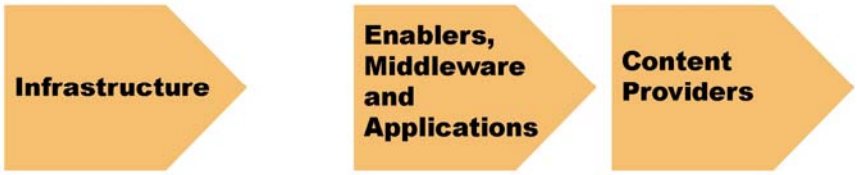
Application	Sector	Components	Equipment and Devices	Enablers and Middleware	Applications and Value Added Serivces	Content Providers	Content Aggregators
Cellular	**Cellular Infrastructure (3G and Beyond & IMS/MMD)**	• PMC Sierra • SiGe Semiconductor • SIGPRO Wireless • Qualcomm • Texas Instruments • Freescale • ST Microelectronics • Renesas • Samsung	• Nortel • TIL-TEK • Nokia • Samsung • Motorola • Lucent • Ericsson • Siemens • Alcatel • Huawei • ZTE • LG	• Nortel • Redknee • Bridgewater • Mobidia • Blueslice • Atlas Telecom Mobile • 724 Solutions • Openwave • Comverse • HP • SUN • Sonus Networks	• OZ • Airwide • Sona Mobile • iamota • Consilient Technologies • Intrinsyc • Kinetix Wireless • SIPquest • Exponentia • Amdocs • Convergys • Portal Software Inc. • CSG Systems • Symbian • Qualcomm (BREW) • Opera Mobile • Microsoft (Windows mobile) • Openwave • SEVEN • VeriSign	• OZ • Airborne • 20Q.net • Bright Interactive • Titanium Mobile • Bell Globemedia • Rogers • Global • Chum • Time Warner • Sony • Disney • Warner Brothers • Universal	• AirG • Airborne • MyThum • Ooober • Tira Wireless • Magnet Mobile • ZIM Corporation • Exponentia • Jambo • m-Qube • AOL • Yahoo! • MSN • Google • Dwango Wireless (Dijji) • U-Turn • MobiTV
	Packet Based Infrastructure		• Nortel • Alcatel • AePONA • Appium • HP • IBM • Nokia • Motorola • Lucent • Ericsson • Alcatel • Huawei • ZTE	• Nortel • Redknee • Convedia • Mobidia • Contec Innnovations • Ericsson • Huawei • Siemens • Cisco • Sonus Networks			
	Service Enablers (SDP, Servers and Gateways)			• Redknee • Bridgewater • Mobidia • Blueslice • Atlas Telecom Mobile • Ericsson • Alcatel • IBM • HP • SUN • Microsoft • LogicaCMG • Ubiquity • Oracle • AePONA • jNETx • Motorola			

Table 2 - Major Canadian and Global Players in the Cellular Market



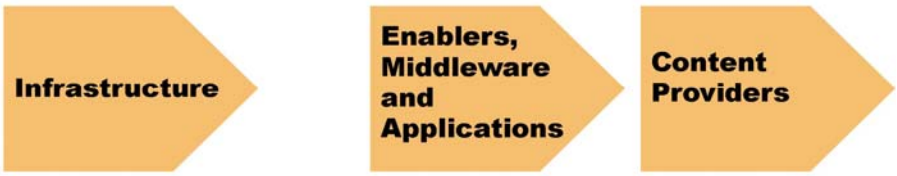
Application	Sector	Components	Equipment and Devices	Enablers and Middleware	Applications and Value Added Serivces	Content Providers	Content Aggregators
Cellular Devices	Handsets	• ATI • SIGPRO Wireless • Gennum • Qualcomm • Renesas • Samsung • Broadcom	• Curo Interactive • Sony - Ericsson • Nokia • Motorola • Samsung • LG • Siemens • Audiovox • UTStarcom	• SIPquest • Symbian • Qualcomm (BREW) • Opera Mobile • Palm OS • Microsoft (Windows mobile) • Linux • SUN • Action Engine • Java (J2ME)	• OZ Communications • Sona Mobile • iamota • Consilient Technologies • Intrinsyc • Kinetix Wireless • AOL • Yahoo IM • ICQ • MSN Messenger • Google • Skype • Qualcomm (BREW)		
	Smartphones, PDA's and Data centeric CPE	• ATI • SIGPRO Wireless • Gennum • Qualcomm • Renesas • Samsung • Broadcom	• RIM • Sierra Wireless • DataWind • Sony Ericsson • Palm • Kyocera • HP/Compaq • Novatel • Nokia • Samsung • Audiovox • UTStarcom • Fujitsu • Siemens	• RIM OS • SIPquest • Symbian • Qualcomm (BREW) • Opera Mobile • Palm OS • Microsoft (Windows mobile) • Linux • SUN • Action Engine • Java (J2ME)	• OZ Communications • Sona Mobile • iamota • Consilient Technologies • Kinetix Wireless • AOL • Yahoo IM • ICQ • MSN Messenger • Google • Skype • Qualcomm (BREW)		
Mobile Data	Messaging, Information Content, Entertainments and M-Commerce			• RIM OS • SIPquest • Symbian • Qualcomm (BREW) • Opera Mobile • Palm OS • Microsoft (Windows mobile) • Linux • SUN • Action Engine • Java (J2ME)	• OZ Communications • Sona Mobile • iamota • Consilient Technologies • Intrinsyc • Kinetix Wireless • AOL • Yahoo IM • ICQ • MSN Messenger • Google • Skype • Qualcomm (BREW)	• Airborne • 20Q.net • Bight Interactive • Titanium Mobile • Bell Globemedia • Rogers • Global • Chum • Time Warner • Sony • Disney • Warner Brothers • Universal	• AirG • Airborne • MyThum • Ooober • Tira Wireless • Magnet Mobile • ZIM Corporation • Exponentia • Jambo • m-Qube • AOL • Yahoo! • MSN • Google • Dwango Wireless (Dijji) • U-Turn • MobiTV

Table 3 — Major Canadian and Global Players in Cellular Devices and Wireless MAN



Application	Sector	Components	Equipment and Devices	Enablers and Middleware	Applications and Value Added Serivces	Content Providers	Content Aggregators
Wireless MAN	**WiMAX**	• Wavesat • Wi-LAN • SiGe Semiconductor • Intel • Fujitsu • Freescale • Philips Semiconductors • Texas Instruments • Broadcom	• DragonWave • Redline Communication • VCom • Wavesat • Alvarion • Motorola Canopy • AirSpan • Aperto				
	Wireless Mesh (WiFi based)	• SiGe Semiconductor • Intel • Texas Instruments	• Nortel • BelAir Networks • Tranzeo • Tropos • Strix Systems • Motorola Canopy • Proxim				
Wireless LAN	**WiFi - Access Points**	• SiGe Semiconductor • Texas Instruments • Intel	• EION • Nortel • TIL-TEK • Cisco • Aruba • Trapeze • 3Com • Juniper Networks				
	WiFi CPE	• SiGe Semiconductor • Texas Instruments • Intel	• Linksys • D-Link • NETGEAR • Buffalo				
Wireless PAN	**UWB and Bluetooth**	• SiGe Semiconductor • Intel • Texas Instruments • Freescale • Renesas • Samsung • Broadcom • Infineon • Blue7	• Wireless 2000 • Icron • Staccato Communications • Belko • HP • Sony • LG Electronics • Wisair • MCCI				
Near Field Technologies	**RFID and NFC**	• Symbol • Texas Instruments • WJ Communications	• EXI (acquired by VeriChip) • Hot Button Solutions • R Moroz • STR International • Synercard • Wireless 2000 • Intermec • PAXAR • Datamax • Symbol • Texas Instruments • TAGSYS				

Table 4 — Major Canadian and Global Players in Wireless LAN, PAN and NFC



Application	Sector	Components	Equipment and Devices	Enablers and Middleware	Applications and Value Added Serivces	Content Providers	Content Aggregators
Wireless PAN	**UWB and Bluetooth**	• SiGe Semiconductor • Intel • Texas Instruments • Freescale • Renesas • Samsung • Broadcom • Infineon • Blue7	• Wireless 2000 • Icron • Staccato Communications • Belko • HP • Sony • LG Electronics • Wisair • MCCI				
Near Field Technologies	**RFID and NFC**	• Symbol • Texas Instruments • WJ Communications	• EXI (acquired by VeriChip) • Hot Button Solutions • R Moroz • STR International • Synercard • Wireless 2000 • Intermec • PAXAR • Datamax • Symbol • Texas Instruments • TAGSYS				
Software	**Software Defined Radio (SDR)**		• Spectrum Signal Processing • ISR Technologies • CRC Canada • Zeligsoft • Vanu • BAE • Futurewei (part of Huawei) • L-3 Communications • Sandbridge				

Table 5 — Major Canadian and Global Players in UWB, RFID and SDR

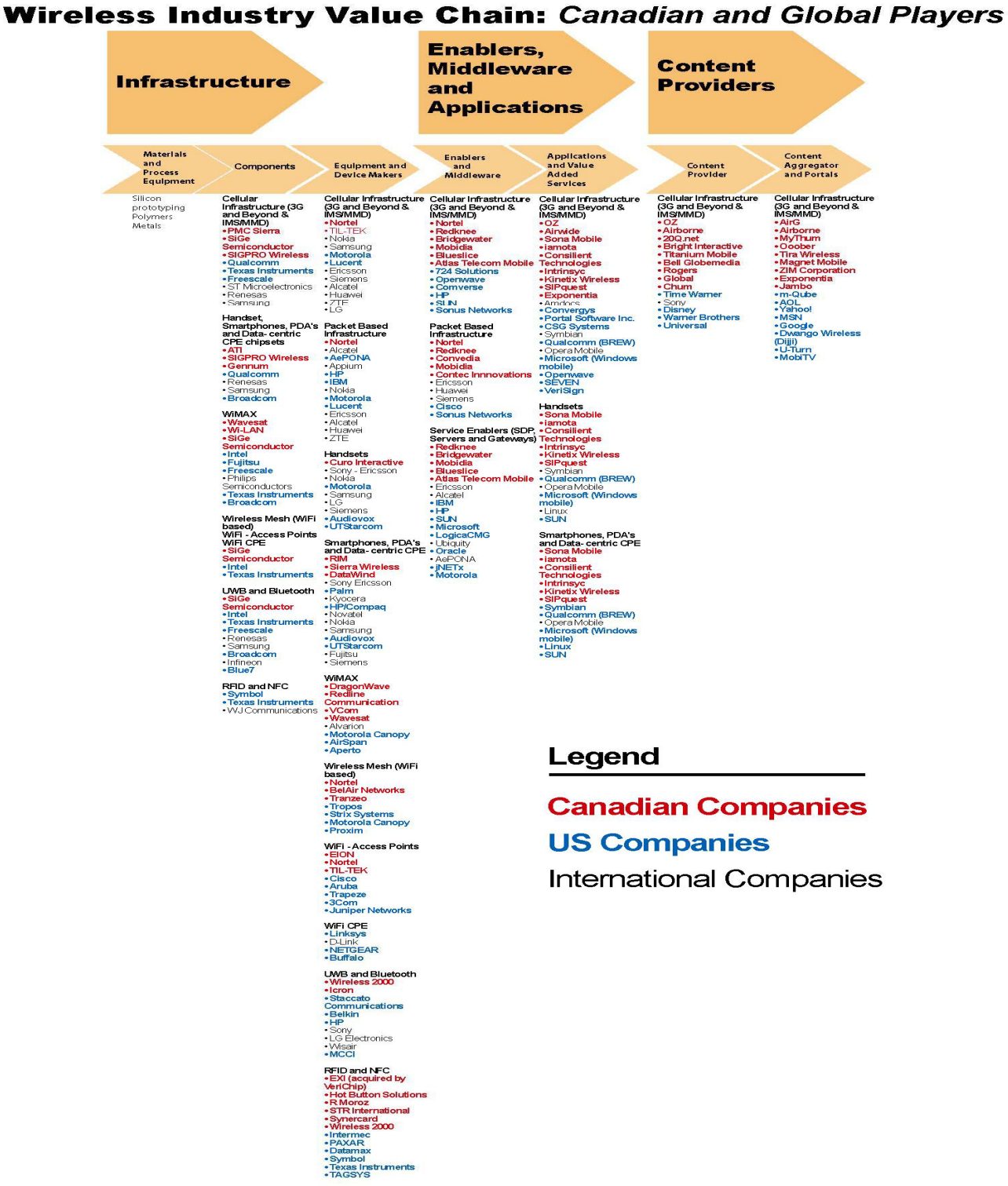


Figure 88 — Wireless Industry Value Chain: Canadian, US and International Players

Positioning of Canadian Wireless Industry vs. US and South Korean Wireless Industry

Canada is an economy on the doorstep of one of the world's largest economies. Through the North American Free Trade Agreement (NAFTA), Canada has relatively easy access to the markets and resources of the US, the sheer size difference between Canada and the US can make them difficult to compare. When measuring the underlying structure and support systems (such as governance, R&D support, research, human capital, etc), we find that the US is very strong in R&D spending and support, holds more trademarks and patents than any other country in the world, and publishes more research than any other country in the world. Much of this is due to having a market that will support both R&D and, importantly, the commercialization of that R&D.

In the next section we compare leading indicator measures of Canada and key markets. These indicators measure the ability of a market to conduct research, develop innovative products and then commercialize and export them. The ratings are relative to the average of the sample (100 percent). In this section, we compare the US, Canada and South Korea. The numbers shown represent the difference in percent of each country from the average of the three (100 percent = Average of Canada, US, South Korea).

The US is about 10 times the population of Canada with an almost one third greater GDP per capita measure. It may be easy to say that the differences are due largely to market size. When we compare our performance to South Korea (a country with approximately 30 percent more people than Canada that has a GDP per capita one third less than ours), which is on the doorstep of Japan and China, we see that South Korea's high tech exports are 76 percent more than Canada's, representing a much larger share of South Korea's total exports. The South Korean exports are proportional to the exports of the US. (South Korea: 32 percent, US: 31 percent, CAN: 14 percent).

One of the key characteristics of the South Korean market is their ability to commercialize. South Korea has been on the forefront of development in wireless content and applications and broadband technologies such as WiBRO.[131] The government has been active in demanding operators adopt new technologies quickly, sometimes at the risk of a poor business case or timing, but this has resulted in a market that is highly competitive, an industry that is actively exporting, and a market that is both engaged and supportive of the latest developments.

The spending trends of Canada and the US, within the wireless industry are very similar, with Canada lagging the US by approximately 25 percent. The South Korean market offers a different profile where, although total wireless spending (voice and data) per

[131] WiBRO is a proprietary version of WiMAX developed in Korea.

subscriber is almost identical for South Korea and Canada, data spending in South Korea is well beyond both Canada and the US (see Figure 89). In our comparison of Canada and US, we include South Korea as a third reference for contrast and perspective.

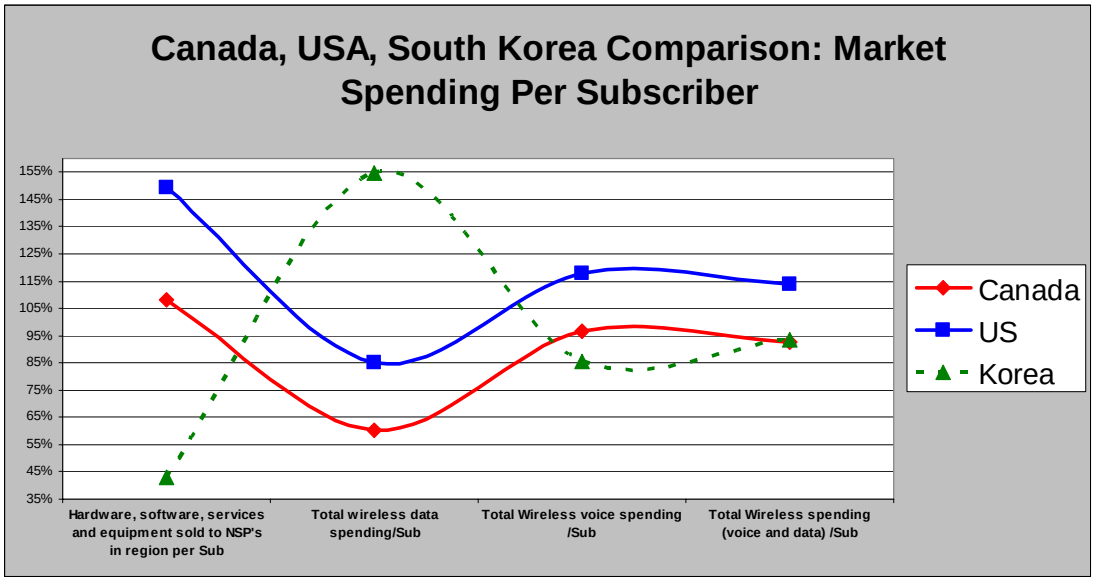


Figure 89 — 2006 Estimated spending by country[132]

A Broader Comparison of Indicators

As size is often considered to be the determining factor when comparing Canada and the US, we have compiled a series of internationally recognized indices and indicators for Canada, US and South Korea (See Table 6). Canada is slightly ahead of the US in the Human Capital Index and relatively close in the Technological Activity Index. These two indices measure the quality and quantity of graduates, the R&D activity of a country and the ability of the economy to support that activity. When the figures are graphed (see Figure 90), Canada is dwarfed by the size of activity in the US and leads South Korea in Royalties received and paid on patents and trademarks, and on scientific journals published (see Figure 91). Where there is a distinct difference between Canada and South Korea is in total high-tech exports, high-tech exports as percent of manufactured exports, patents and trademarks filed locally by residents, and R&D spending as a percentage of GDP. South Korea's spending on R&D is comparable to the US and high-tech exports as a percentage of manufactured exports surpass that of the US.

[132] Source: IDC, *IDC Black Book 2005*. NSP's= Network Service Providers, total voice/data spend refers to total revenue from service, Percentages are derived from the average score. The percentage score is the difference between the country score and the average of the three scores.

This comparison shows that although Canada rates better for human resources and academic activity, South Korea is investing heavily in R&D and actively exporting at a high rate. The indices at the bottom of the chart are indicative and accurate for western countries (see Figure 90). These indices, especially for patents registered with the USPTO, as measured by the Technological Activity Index, may not be an accurate representation of the number of patents filed by South Korean firms, as many may file locally. All things considered, some R&D, or innovation creation, is not clearly measurable, as not all of it falls under the "technological invention" category. Some is process based; some is incremental improvement; while at times, it exhibits itself at every stage of the value chain. An example of this is RIM's Blackberry™ device. RIM holds several patents and trademarks for their products, but the value is created through the combination of those technologies and the processes involved in creating a complete user experience, much of which was not developed through R&D spending alone.

These indicators suggest that although Canada has the people, the know-how and the investment, South Korea has the output and the success that Canada does not. The next section will look deeper to understand the reasons why and understand the differences.

Research and Development	CAN	US	S. Korea	Comparison
R&D Spending as Percent of GDP	80%	114%	106%	Canada significantly lower, S. Korea similar to US
Patents and Trademark Royalties Received	15%	278%	8%	S. Korea and Canada Similar
Patent and Trademark Royalties Paid	51%	211%	38%	US far ahead but Canada 13 percent above S. Korea
Scientific and technical Journal Articles published	29%	257%	14%	US far ahead, S. Korea is half of Canada
Total high-tech exports	29%	200%	71%	Canada low, 42 percent behind S. Korea
High-tech exports as percent of manufactured exports	55%	121%	125%	US and S. Korea similar, Canada far behind
Patents and trademark applications filed locally by residents	12%	200%	88%	Canada very low, but many patents may be filed in US, S. Korea comparatively strong

Human Capital Index	**102%**	**101%**	**97%**	**Canada ahead in population capability, all countries similar**
Technological Activity Index	**102%**	**107%**	**92%**	**Canada close to US in capability (includes patents filed by Canadians in US)**

Table 6 — Comparison of Canada, US and South Korea, measures from World Bank Global indicators and World Investment Report

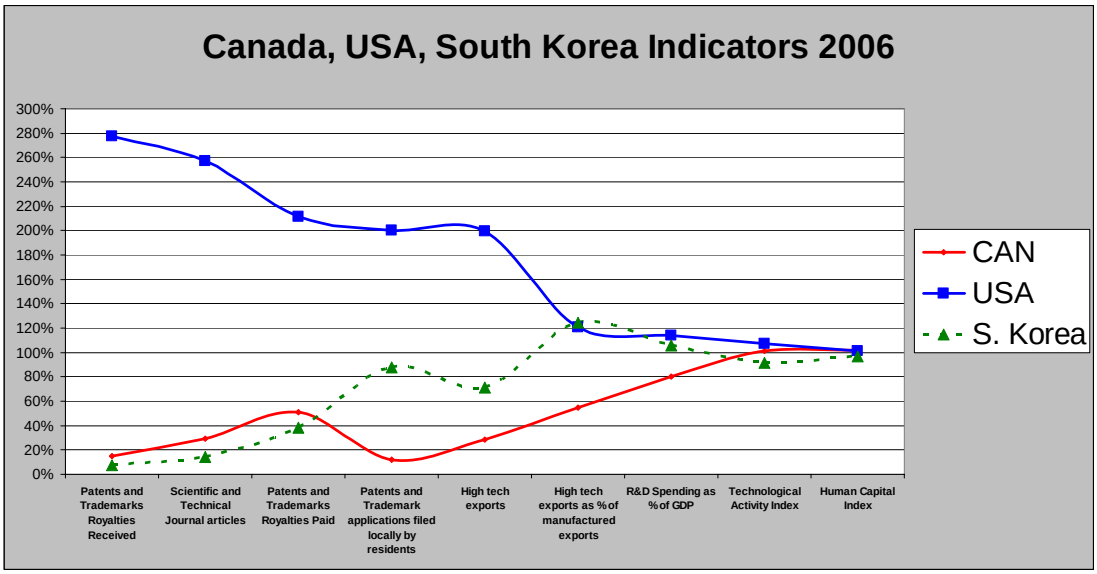


Figure 90 — Comparison of Canada, US and South Korea[133]

Canadian R&D and the Canadian Market

Canada has an R&D community, which has produced innovative solutions that have been successful on the world stage. Many of the wireless vendors in Canada are small, nimble R&D houses that have come up with unique solutions for niche markets. WiLAN is an example of a company that developed its business in the late 90's through wireless local loop solutions in developing Africa and has recently decided to focus only on intellectual property for OFDM and broadband wireless access technologies. RIM is an example of innovative thinkers coming together to create a unique solution for push mobile email that is catching on across the world. As part of this study, KAZAM conducted both a web survey and direct interviews with several Canadian companies across the country. From our

[133] Source: World Bank Global Indicators 2005, World Investment Report 2005.

discussions, many Canadian companies have developed solutions that do not have a market in Canada, or the local market has not been ready to consume their solution yet. As a result, in the case of some vendors, a large majority of their business is done overseas. The ability to support R&D through commercialization is vital to the strength of a value chain, and this appears to be a key challenge within the Canadian Wireless Ecosystem Value Chain.

The Role of Market in International Competitiveness

Privileged relationships and assets, high tariff walls, and a captive market of local customers are usually characteristics that we associate with emerging countries. Yet still we see emerging countries producing true global leaders (Samsung and LG, both of South Korea; and HSBC of Hong Kong), operating diverse businesses profitably, at scale, and in a wide range of geographies.

In the emerging world, the combination of demanding yet price-sensitive customers and challenging distribution environments can help determined companies develop the distinctive capabilities they need to compete successfully elsewhere.

In South Korea, Samsung Electronics local conditions are a driving force. With intense competition from national rival (LG Electronics), by the mid-1990s Samsung was the domestic market leader in its core businesses: appliances, consumer electronics and semiconductors. Driven by very demanding high-tech consumers in the home market, the company built up strength in product design and operations, taking advantage of synergies between semiconductor and consumer businesses, and building competencies in turning new designs into manufactured products quickly. Samsung rapidly established international R&D centres and uses the competitive home market as the prime testing ground (see Figure 91).

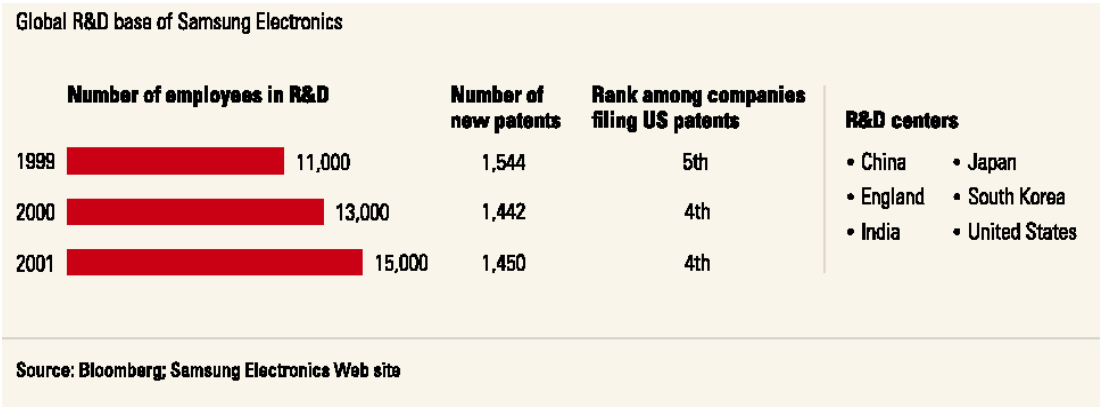


Figure 91 — R&D base of Samsung Electronics

The competitiveness of the South Korean market has acted as a springboard for Samsung and has driven it to become a global player. It has also acted as a springboard for Samsung home rival, LG Electronics, another global player.

Canadians have historically been particularly successful at developing innovative, if not revolutionary ideas and concepts for specific niche markets and purposes. Canada has had challenges in the local commercialization and local adoption of those ideas and concepts. The potential future influx of new and disruptive business models and new technologies may act as a kick-start to both the domestic and international activity of the Canadian wireless sector. With Canada's strengths in R&D tax support, talent and resources, there is the potential for the emergence of powerful global players.

As discussed in recent research from Institute of Competitiveness and Prosperity,[134] the creation of innovation is reliant upon pressure and support to drive all three elements of the innovation value chain: Supply of Innovation, Financing of Innovation and Demand for Innovation.

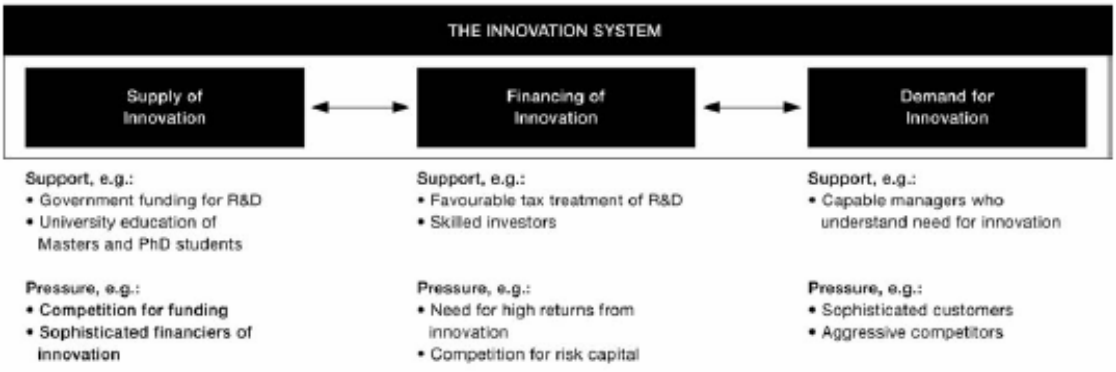


Figure 92 — The Innovation System, Roger L. Martin, James B. Milway[134]

The Innovation System

Martin and Milway analyze and describe the dynamics of The Innovation System in terms of pressure and support drivers for the Supply of Innovation (creation), Financing of Innovation (access to and quality of capital) and Demand for Innovation (commercialization of R&D) (see Figure 92). Their Innovation System follows a parallel form to our wireless value chain of previous chapters. They describe how each stage requires both support, to make its task easier; and pressure, to provide incentives and stimulus to push farther ahead. A summary of Martin and Milway's Innovation System Analysis follows.

[134] Source: Roger L. Martin, James B. Milway: *Commercialization and the Canadian Business Environment: A Systems Perspective, Comments on Public Policy Support for Innovation and Commercialization in Canada*, July 2005: http://www.competeprosper.ca/research/InnovationSystem_040705.pdf.

Supply of Innovation comes from activities and resources in universities, laboratories and corporate R&D operations dedicated to creating new knowledge. It is supported by government funding of R&D and the innovation that comes from the advanced activities and thinking engaged in by Masters and PhD students. Innovation can be developed other ways but these are likely small compared to the impact of the above.

A supply of innovation does not necessarily dictate that the quality of innovation is high. Pressure applied through commercial or peer-reviewed competition for research funding and sophisticated investors creates the need for upgrading the innovation supply. Investors that are hands-on, providing both human and monetary capital add tremendous value, particularly at the commercialization level.

Financing of Innovation consists of the various sources of capital available: Angel Investment, Venture Capital, Public Equity financing and Debt Financing. It is supported by such factors as favourable tax treatment of R&D and skilled investors. It is pressured by the need for high returns from innovation and through competition for risk capital.

With an investor, driven by future return on investments (ROI) requirements and backed by market expertise and resources, the inputs to the development of innovation supply are increased, forcing innovation to attain higher goals. The competition for risk capital increases the need for innovation to be analyzed and evaluated for marketability and overall value.

Demand for Innovation is the direct compliment of supply, and consists of the active market and the players in that market who ultimately use or sell the innovation. Customer insistence for new products and breakthroughs stimulates the innovation system at every level and a business environment where there is sufficient corporate demand that CEO's allocate corporate resources to innovation vs. existing activities or current profit.

Demand for innovation is supported by capable managers who understand the need for innovation and who are in tune with developing customer traits. Demand is pressured by sophisticated customers demanding better and aggressive competitors and replacements who threaten current positions.

Canada Compared to the US

Supply of Innovation: Canada vs. the US

There is high government funding in Canada for R&D. As Martin and Milway describe, that funding takes many forms but is narrowly focused on hard sciences such as engineering with little attention paid to business R&D. They illustrate how Canada has one of the most generous tax incentive programs yet mediocre investments in business R&D (see Figure 93). They suggest that Canada's focus on tax credit systems, to support R&D, are not strong incentives for business, that

the taxation levels in Canada (soon to be the highest in the world) further inhibit investment in innovation (keeping a focus on protecting existing revenue streams) (see Figure 94). They suggest that the nature of how R&D tax incentives are distributed (particularly Labour Sponsored Investment Funds [LSIF]) do not promote institutional investment, provide money regardless of innovation potential (due to tax incentives providing required return) and in effect, create an environment where there is little pressure on R&D to perform and improve. Martin and Milway suggest that the quantity of R&D funding is there but that the quality (pressure) is low.

To compare the quality of innovation in Canada with the US a key measure of innovative capacity and processes is patenting. Martin and Milway, in conjunction with the Institute for Strategy and Competitiveness, compiled a comparison of Canada and the US based on patents within traded industries, registered in the US by Canadian Inventors. Their findings conclude that Canada's mix of clusters should be producing patents at approximately 25 percent behind peer states; instead Canada trails by 70 percent per employee (see Figure 95). They conclude that over half of this disadvantage is due to lower effectiveness.[135]

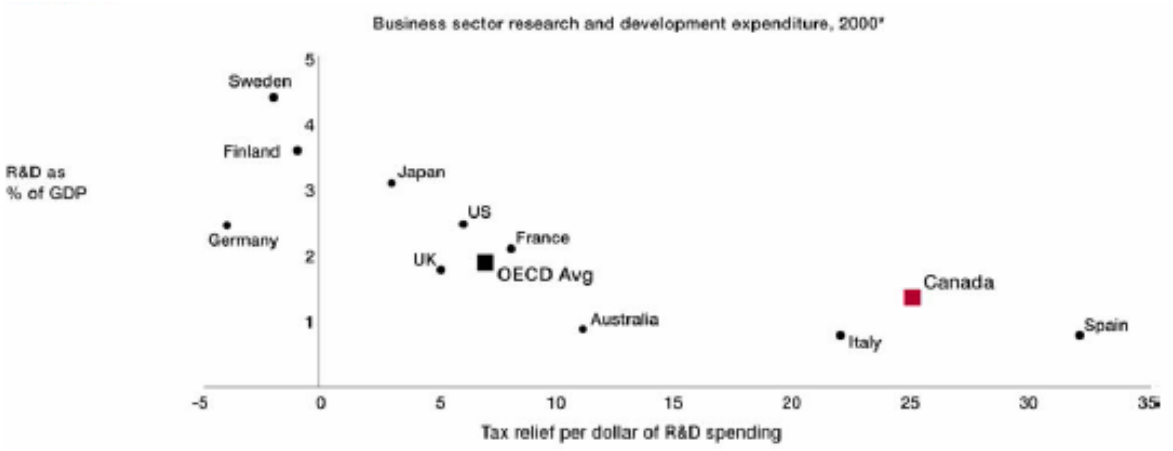


Figure 93 — Business Sector Research and Development Expenditure, 2000[136]

[135] Source: Roger L. Martin, James B. Milway: *Commercialization and the Canadian Business Environment: A Systems Perspective, Comments on Public Policy Support for Innovation and Commercialization in Canada*, July 2005, p. 5,: http://www.competeprosper.ca/research/InnovationSystem_040705.pdf.

[136] Source: Institute for Competitiveness and Prosperity, based on OECD economic Surveys Canada — Volume 2003/14 — September.

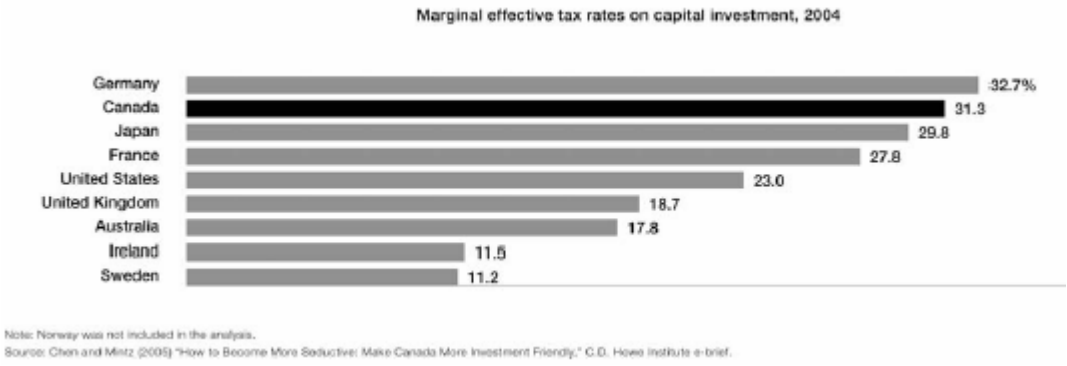


Figure 94 — Marginal effective tax rate on investment is much higher in Canada than other developed countries[137]

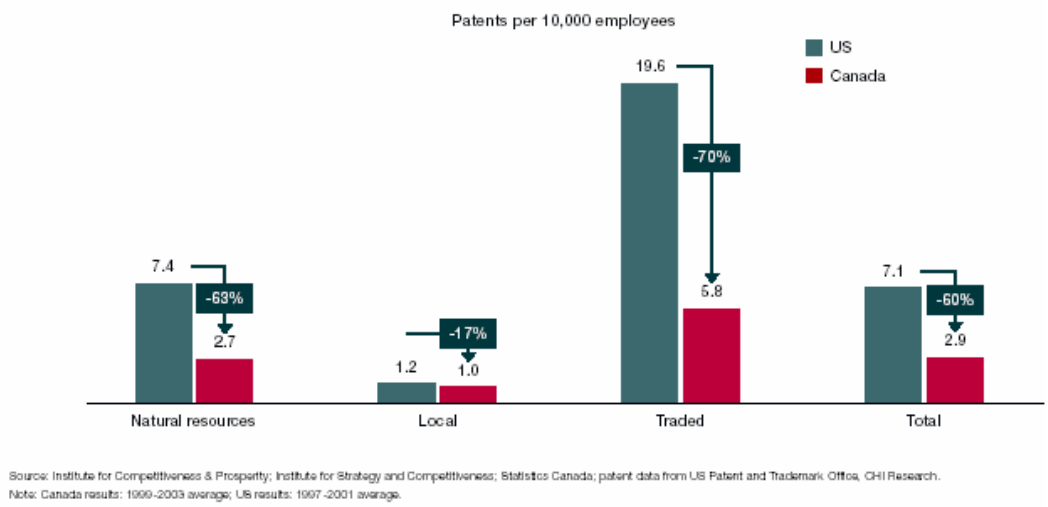


Figure 95 — Canada Trails US Patent output, particularly in traded industries

Financing of Innovation: Canada vs. US

As mentioned, LSIF offer generous tax incentives to individuals to invest. Martin and Milway state that because the fund offers such generous return on investment (as much as 10.8 percent annual return) regardless of fund performance, there is little incentive to be concerned with the actual performance of the fund. This in turn reduces the pressure on the R&D community to move forward. Martin and Milway conclude that this instrument should be abolished with a greater focus on reducing business taxes and strengthening the quality of financing for innovation.

[137] Source: Roger L. Martin, James B. Milway: *Commercialization and the Canadian Business Environment: A Systems Perspective, Comments on Public Policy Support for Innovation and Commercialization in Canada*, July 2005, p. 15, http://www.competeprosper.ca/research/InnovationSystem_040705.pdf.

They conclude that support to increase the quantity of venture capital is not the answer either as venture capital funding has been in line with US (aside from dot-com bubble) (see Figure 96).

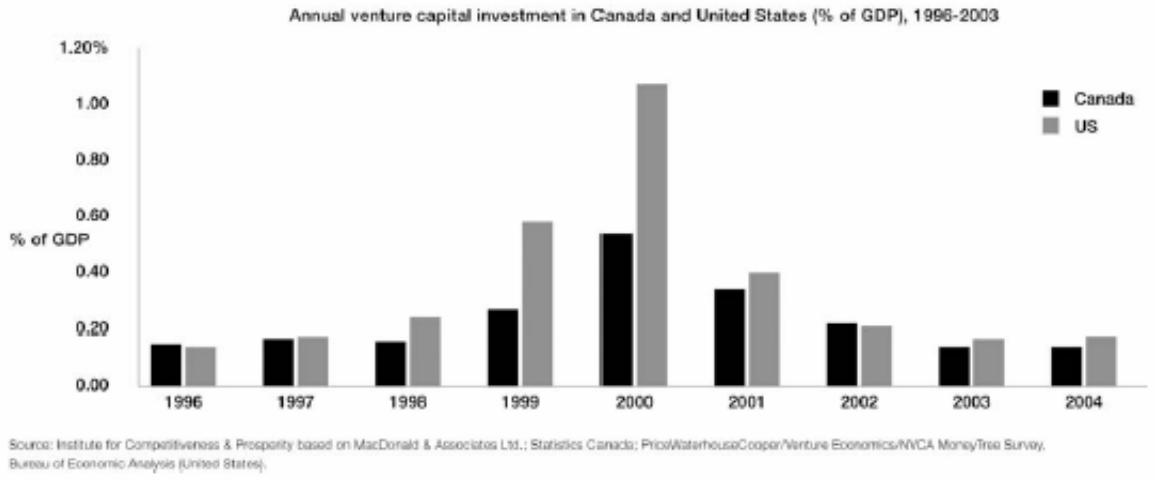


Figure 96 — Venture Capital in Canada compared to the US

This aligns with our measure Capital Access Index where Canada and the US were at par (CAN: 7.42; US: 7.75). Martin and Milway state that the difference is not quantity of capital available but the quality, as a result of the relatively relaxed levels of investor pressure and involvement with innovation firm development.

They cite a study by The Strategic Counsel, a Toronto-based market research firm, where 27 firms were interviewed in Ontario on the role and function of their venture or angel investor. The result indicated that venture firms were not providing much support beyond helping with capital and some business strategy support (see Figure 97). Successful venture capital firms not only provide financial resources but also lend expertise and skills to guide fledgling firms and help drive innovation and commercialization of innovation. On several factors critical to the success of any start-up, more respondents indicated that their venture capital firm was not important to their success as compared to those that indicated they were important.[138] They note that current efforts by the industry through the Canadian Venture Capital Association to enhance pension fund managers' understanding of the sector and efforts to improve information on returns is a strong positive step.

Martin and Milway conclude that significant change will occur through the broadening of support provided by venture capitalists and the creation of a climate

[138] Source: Roger L. Martin, James B. Milway: *Commercialization and the Canadian Business Environment: A Systems Perspective, Comments on Public Policy Support for Innovation and Commercialization in Canada*, July 2005, p. 11, http://www.competeprosper.ca/research/InnovationSystem_040705.pdf. Survey results are available at the Institute of Competitiveness and Prosperity website www.competeprosper.ca.

where pension funds will invest in this asset class, increasing pressure to upgrade quality.

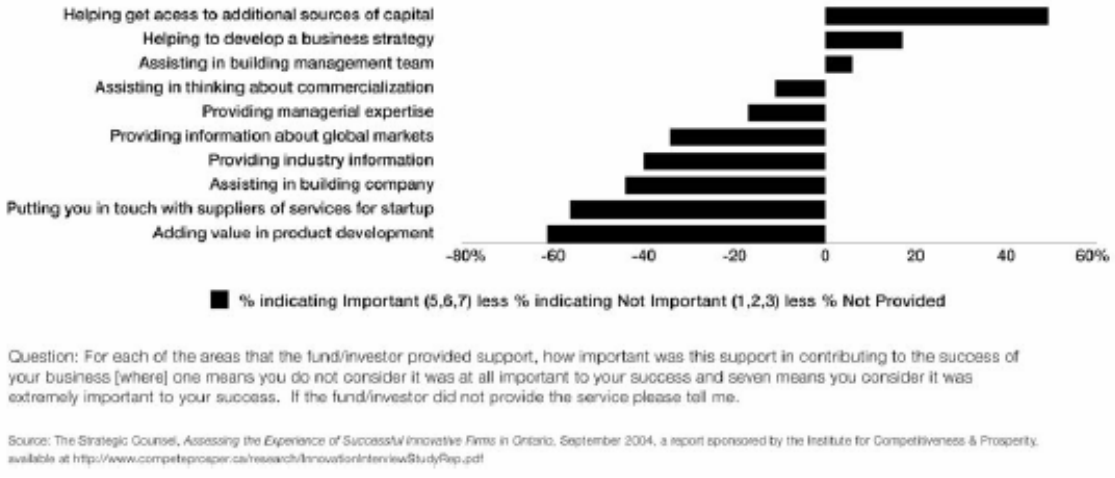


Figure 97 — Venture investors do not provide a complete range of support to innovative startup firms

Demand for Innovation: Canada vs. the US

Martin and Milway explain how sophisticated management is a key support mechanism for Demand for Innovation, similar to how, in previous chapters, we describe management and governance as a key step in the value chain. Compared to the US, CEOs of Canada's largest corporations tend to have less formal business education at the graduate level, and Canadian managers have lower overall educational attainment than US counterparts. In Canada, 31 percent of managers possess a university degree vs. 50 percent of US managers. Fourteen percent of Canadian managers have less than high school vs. 2 percent in the US (see Figure 98). The authors state that the more educated managers are, the more likely they are to think strategically, to operate more effectively, to see the value of innovation and demand more from innovation. Our lower education level of human capital resources in management suggests that we may have real challenges when it comes to managing, commercializing and marketing innovation.

The study outlines how a commonly held idea is that technology companies are fundamentally different than most businesses and must be led by graduates of technology disciplines. The study contrasts this with the fact that seven computer and telecom Fortune 100 companies in the US have CEOs with business backgrounds, five of which are MBAs. These are companies, which had long histories of CEOs with technical backgrounds such as HP, Dell, Microsoft, Cisco, Motorola, Intel and IBM.

Canada's population is geographically dispersed, presenting cost problems for operators and vendors alike, that promotes a cost saving, protective approach.

There are many markets in Canada where achieving service is the main priority, particularly in smaller centres where the cost of infrastructure is high to reach small populations. New, disruptive technologies such as WiMAX, VoIP and WiFi Mesh and new entrants and business models such as unicipalities, branded MVNOs, Skype and the yet undiscovered may change this quickly and radically. This new playing field will demand innovation of the existing players for survival. Currently, the only option for many companies is to develop technologies to be sold into the demanding and competitive US and international markets. Recognized as a disadvantage when compared to the US, many Canadian firms do not have the local market to stimulate innovation development and refinement (see Figure 100).

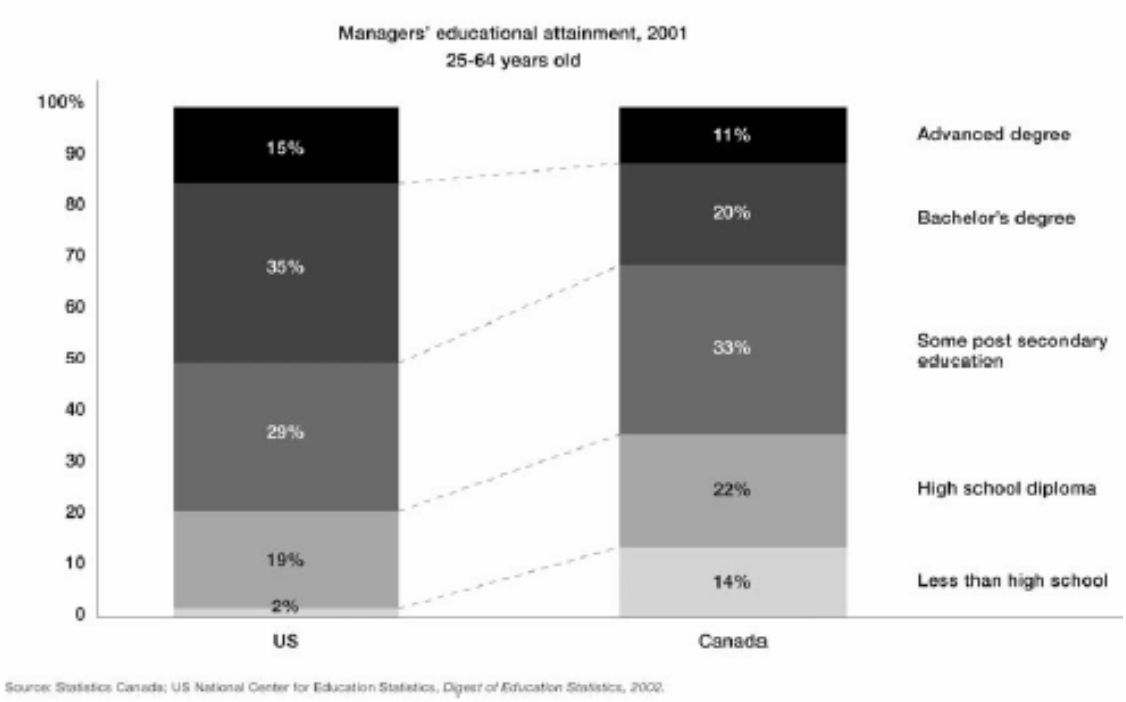


Figure 98 – 31 percent of Canada's managers have a bachelor degree or better vs. US at 50 percent

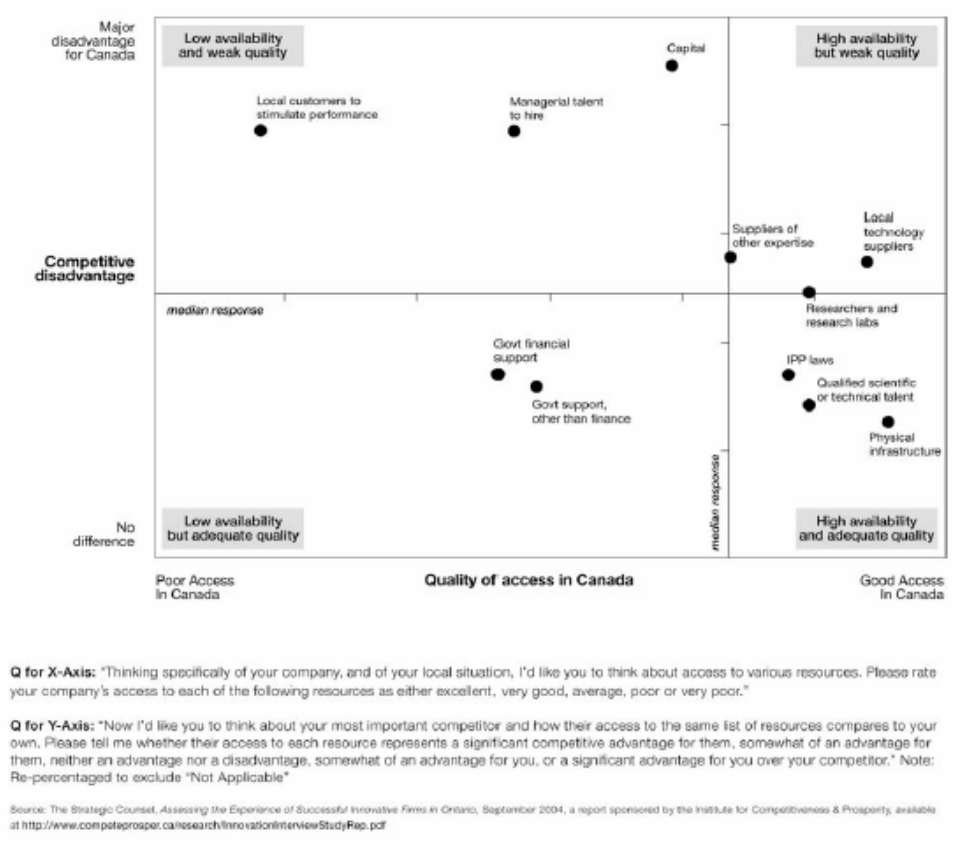


Figure 99 — Access to management talent is a key weakness for Canadian innovative startups relative to US competitors[139]

Summary of Martin, Milway

"Strengthening Canada's capabilities in the area of innovation and commercialization are critical elements of our economic and social agenda. To do this we need a system-wide approach. Our assessment of public policy in Canada indicates that it has focused too much in the area of providing support for the supply of innovation and it's financing. It has not adequately addressed areas that provide pressure for greater demand for innovation by our business leaders. Our innovation and commercialization capacity will be strengthened by addressing a broader range of challenges in our business environment and in our innovation financing system.[140]*"*

[139] Source: Roger L. Martin, James B. Milway: *Commercialization and the Canadian Business Environment: A Systems Perspective, Comments on Public Policy Support for Innovation and Commercialization in Canada*, July 2005, p. 17, http://www.competeprosper.ca/research/InnovationSystem_040705.pdf.

[140] Source: Roger L. Martin, James B. Milway: *Commercialization and the Canadian Business Environment: A Systems Perspective, Comments on Public Policy Support for Innovation and Commercialization in Canada*, July 2005, p. 24, http://www.competeprosper.ca/research/InnovationSystem_040705.pdf.

The study presents a comparison of the Innovative Capacity Index (NICI) and the associated sub-indices for Canada and the US, presented to show the primary disadvantage of the Canadian market vs. the US. The study finds that the most significant weakness is in operations and strategy (see Figure 100).

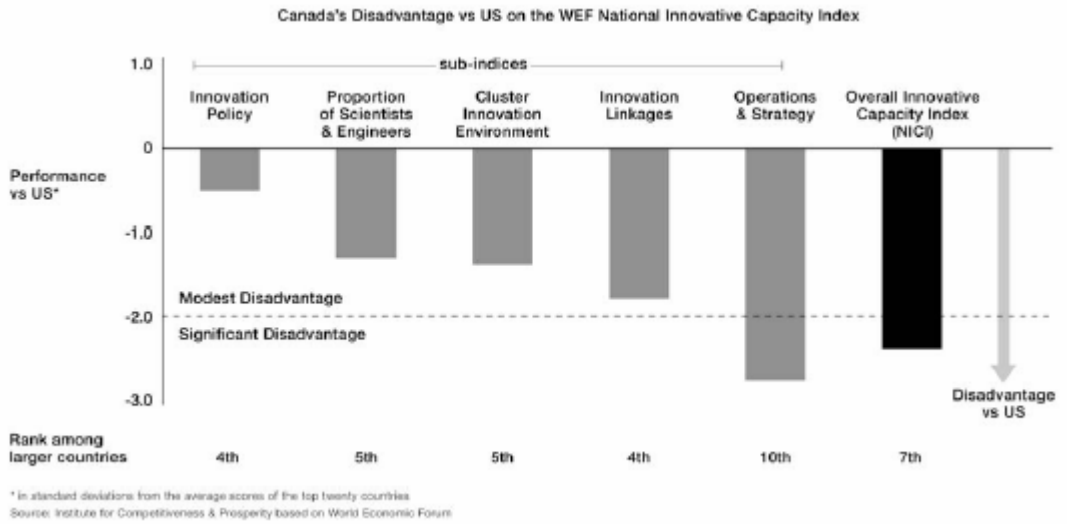


Figure 100 — Canada lags US innovative capacity largely because of company operations and strategy

Overall Canada outperforms the US on “general support” factors such as quality of education and judicial systems (see Figure 101). However, it is weak on “Specialized Support” (see Figure 102) and “Competitive Pressure” factors (see Figure 103).

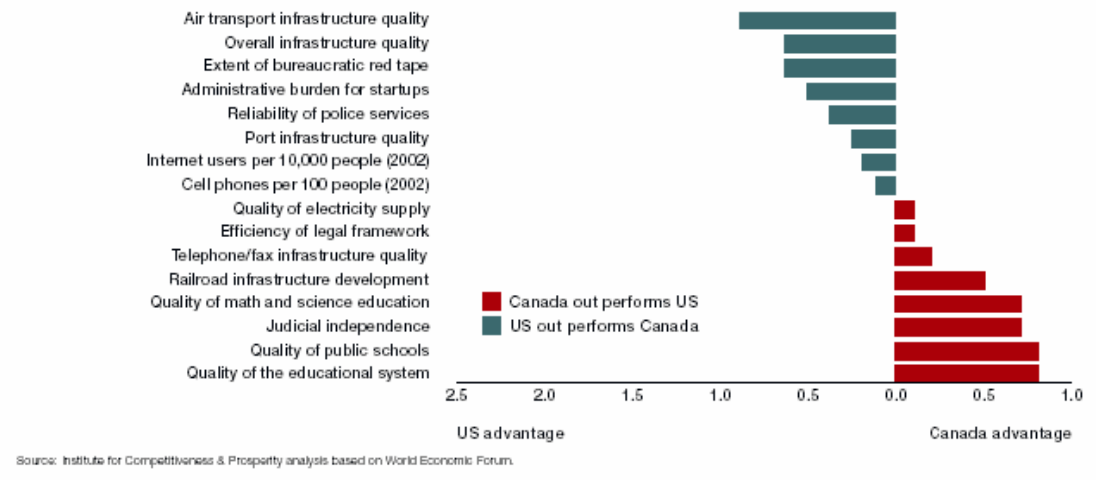


Figure 101 — Canada Outperforms US on "General Support" factors

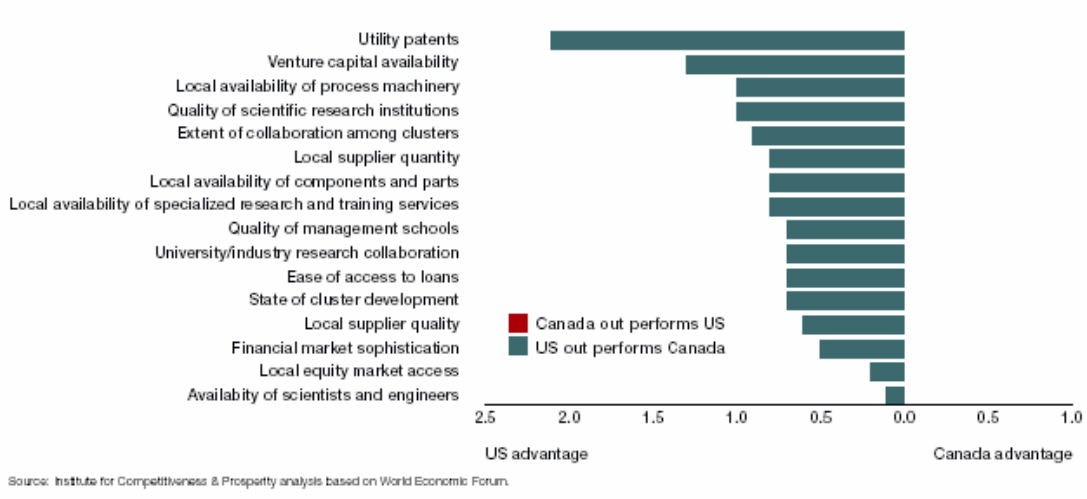


Figure 102 — Canada is weak on "Specialized Support" factors

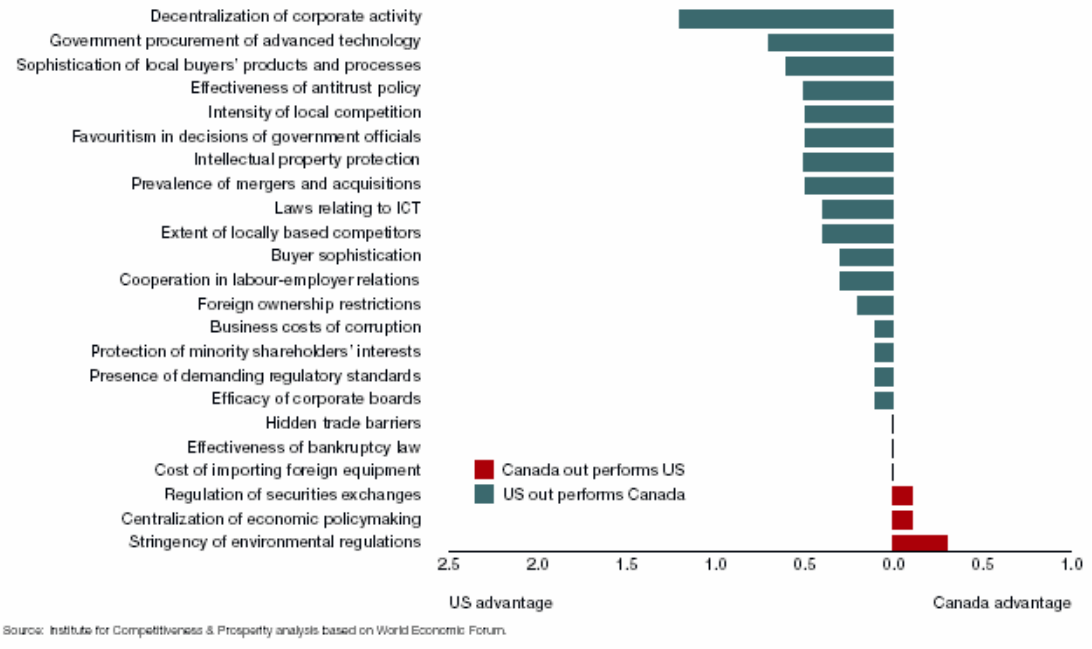


Figure 103 — Canada Trails US on "Competitive Pressure" factors

US as a Market for Canadian Companies

The US as a market for Canadians is lucrative, large and active, with Canada-US trade topping over US$380B last year. The US is close by, the language is the same and the laws are very similar. Canadians with unique solutions can and do have great success in the US market, but there are subtle differences that can create challenges for Canadian companies as well.

The US Government is closely involved in commerce and industry with the economic power to make or break ventures. The legal environment can become a tangle of government and corporate interests as we have seen recently with the copyright hearings that have endangered and slowed expansion of RIM products in the US market, while competitors gain traction with their solutions.

The US market has been relatively strong in wireless voice and data spending, but it is believed to have peaked for voice spending and is likely to level off. If the market levels and slows, US markets will be looking for new solutions that will expand markets, expand services, increase loyalty and increase the share of the wallet. WiMAX and WiFi mesh offer solutions to urban and rural expansion of broadband, an area where the US has lagged Canada. RFID applications and deployments are moving forward daily with powerhouses such as Wal-Mart and the US Government establishing RFID as the standard in retail and identity protection/security.

The market for cellular equipment is expected to drop slightly by 2008,[141] not the best news for companies such as Nortel, but new technologies are expected to grow. WiMAX is expected to grow almost half a billion dollars, RFID over $.5B and WiFi by over $1B.[142] The handset market will also grow driven by net additions and replacement handset sales. These growth levels are small compared to the expected growth of mobile data (content and applications) at over $15B.[143] The growth of this sector is in line with the expansion of 3G networks, wireless broadband and the natural evolution of mobile from straight voice to more sophisticated applications.

The new technologies represent opportunities for Canadian companies within these sectors (WiMAX, WiFi, RFID) and the reward potential is contextually high for fledgling technology startups. The growth potential of these industries may not be enough for companies with higher growth aspirations though and these companies will also have to look to international markets for growth. As these technologies mature, the industry is likely to see levels of consolidation. Canadian technology companies can become possible acquisition targets for US companies.

The real growth opportunity in the US is in mobile data and applications. Canadian wireless operators are at a similar point in the development cycle as more and more data applications and options are being offered to the public. RIM is in an interesting position as they have entered the US market with both a handset and data package as an integrated suite.

Mobile data is a broad category and the ability of a company to capture significant pieces of this market is not a simple task. Mobile data is made up of many different components working together: applications, services, content, branded content, systems integration,

[141] Source: IDC, *Worldwide Wireless and Mobile Network Infrastructure 2004 – 2008 Forecast and Analysis*, December 2004.

[142] KAZAM WiMAX, WiFi and Wireless Mesh Forecasts, 2006.

[143] KAZAM Mobile Data Forecasts, 2006.

access, back end and user experience. RIM has come to market with a compelling package that, although not a majority share force in the marketplace, is a strong and innovative niche player. That strength is not coming from individual applications, a single handset, a single technology, but from the value created from the entire package. The development of such packages requires the development of innovation in technology, but also processes, incremental improvement and innovative thinking at each level of the value chain. Marketing and customer support begin to play a role that is often more significant than the strength of a technology and innovation at this level becomes crucial. There is an opportunity for creators and aggregators of content, developers of applications, system integrators and the back end systems required, but there is also an opportunity for Canadian operators who innovate on their business models to take advantage of this new growth. We have seen US companies enter Canada with pure-play VoIP applications and we have seen Skype grow to account for 49 percent of all North American VoIP traffic (Sandvine, August 2005).

As outlined by Martin and Milway, Canada's government-based R&D funding is focused on hard science and does not support the above-mentioned activities. The work required to achieve these goals will be the responsibility of the companies involved and their stakeholders. Cooperative action between companies at each level of the value chain will benefit the companies involved, the industry in Canada, the market in Canada and the potential for trade in international markets. Bringing these companies together is a prime role for the various clusters and wireless associations.

Canada is a desirable location for R&D centres. Due to the generous tax incentives, government support, the strong talent pool and the desirable quality of life, many international companies have set up R&D facilities here. Ericsson has its largest R&D centre (not counting the one in Sweden) located near Montréal. Ericsson, like other multi-nationals, provides its own competition for research funding and demand for innovation stemming from activities in competitive international markets, an advantage over locally based companies. Based on the analysis by Martin and Milway, a foreign company can benefit more from R&D activities in Canada, than a local company.

US as a Competitor to Canadian Companies

As the US continues to act unilaterally and strain long standing international relationships, the number of countries who are reticent to accept US trade and investment is increasing. Parts of South America and the Middle East represent large markets that are open to foreign investment but are reluctant or simply not open to business with US firms. Internationally, Canadians have a reputation for being "gentleman negotiators," and there have been some instances where Canadian companies have been more successful than American companies (oil and gas development in Russia). Canadians have an opportunity to develop business relationships where US companies cannot.

On the other hand, the US holds tremendous influence in many large markets and contracts, which can mean stiff levels of competition.

Competition in Canada is growing as new technologies enter the marketplace and outdated business models are replaced. Vonage is an example of inroads being made into the Canadian marketplace by an American company, forcing operators to rethink strategy and introduce new technologies. As new business models and new technologies emerge and mature, Canadian operators will have to innovate.

In 1997, Vodafone was mostly a regional carrier in the U.K. They had dabbled in acquisitions but were by no means a giant. The CEO of the time recognized that the market was changing and growing and it was up to them to be a part of it or not. He delivered a speech, known later as the famous "eat or be eaten" speech. From this point, Vodafone embarked on an aggressive acquisition program that has led them to be the number two cellular company in the world by subscribers and #1 multinational operator.

Lessons from South Korea

South Korea has approximately one-third greater population and one third less GDP per capita than Canada. It invests over 30 percent of its GDP into R&D, similar to the US, and has become a proving ground for wireless technologies destined for world markets. Products are tested and commercialized in South Korea before being rolled out to neighbouring Japan and beyond. A key difference between South Korea and Canada is population concentration. Canada's population is very geographically dispersed, whereas South Korea is relatively concentrated and primarily urban, making product rollout less capital intensive and adoption of new technologies and ideas faster. South Korea is a highly competitive market whereas Canada is not as competitive, relative to South Korea, particularly where geography and low populations limit the potential for profits.

For example, South Korea made a decision to force operators to adopt WCDMA only months after the launch of EVDO. What the South Korean government did was create demand for innovation within the marketplace. South Korean vendors needed to innovate and develop WCDMA equipment and handsets to ensure profitability and the whole value chain had to work together to ensure success. In addition to being early adopters of technology, South Korean operators are also very good at creating innovative value-add services to fully monetize the infrastructure investment. Through aggressive attention to data services, content and applications, South Korean operators consistently seek out and create market demand for innovative services. In the mobile content arena: they invest in content developers; they bring ideas to promote new content; operators tend to share a larger percentage of content revenues with content providers (80–90 percent); operators partner with content providers and others to aggressively market and promote content; and they have created simpler and more engaging end-user experiences through investment in mobile portals and intelligent mobile agents to drive content usage. In a nutshell, they didn't wait for market demand to grow, they created the right user experience, drove market awareness through target marketing and promotions and thus created demand for new value add data

services. This is an approach that is very different from the approach generally found in Canada, where operators will tend to wait for a combination of technology maturity and market demand. While a "smart follower" strategy for technology may be safe, it creates a degree of stagnation in the local value chain. The result is, South Korea has one of the highest data spending per subscriber (see Figure 90) of any country in the world and is positioned to take advantage of the tremendous growth forecasted for mobile data.

Value Chain Comparison: Canada vs. US

INBOUND LOGISTICS: Technology and Service Development

Canada has very generous tax incentives for R&D but lacks "pressure" from sophisticated and involved investors and competition for capital to improve the quality of R&D. Canada is an excellent location for foreign direct investment in R&D by multi-nationals, it is also an excellent location for Canadian companies that are driven by the competition of international markets. Participating in highly competitive markets is a means by which Canadian companies can replace the lack of "pressure" within the Canadian marketplace.

OPERATIONS: Governance, Strategic Management, Finance

Canada is strong on governance and stability. Strategic management lags when compared to the US with lower educational attainment of managers. Finance is less sophisticated and offers less support to fledgling startups and government incentives focus on hard science without supporting business R&D. There is a recognized need to create incentives for pension funds to invest in R&D, which will require up to date and standardized valuation and reporting protocols.

OUTBOUND LOGISTICS: Commercialization, Bring to Market

With less sophisticated management, innovation is on a mediocre level when compared internationally. Focus of companies, particularly operators, is cost reduction and control and holding market instead of investing heavily in innovation. Canada has lagged the US in product and service introduction.

MARKETING and SALES: Competitiveness and Value Creation

From a wireless perspective, Canada is not as competitive a marketplace as the US Many areas are still largely monopolies creating little incentive for value creation and little pressure for innovation demand.

SERVICE: Retention and Loyalty Creation

Canada has invested extensively in call centres and the creation of automated support systems. Some Canadian operators boast some of the lowest churn rates and highest ARPUs in North America. The danger here is that much of the stability of these rates may be due to limited competition. This will change as new disruptive technologies and business models enter the marketplace. These changes are likely to come from the US, but it is up to Canadians to invest in innovation at both the technology and business level to create value and advantage.

MARKET: Market Needs and Abilities

The Canadian market is one tenth the size of the US market. It is more geographically dispersed but it is also more ethnically and culturally diverse. It is considered more creative than the US and has a much lower poverty level — the quality of life is generally better in Canada. Developing markets for advanced services is possible but will require operators and vendors to work together to create value propositions that are meaningful to Canadians. Investing in this kind of innovation will not only stimulate the Canadian market but will also stimulate development in Canada's wireless value chain at every level, pushing Canada's international position further ahead.

Positioning of Regional/Clusters in the Value Chain

The role of regional clusters and associations is primarily to bring together different players within the industry, lobby for change and provide both a collective forum and voice. The ideal role of the association is to act as a portal to the industry for both industry members and outside parties.

A key strength of both the US market and the South Korean market — two markets that lead wireless technology exports — is the ability of companies to commercialize R&D quickly and refining their products ready for export. South Korea often pushes for technology when it is at what many consider far too early a stage (i.e. WCDMA). This project was not necessarily profitable in the South Korean market, but it has pushed South Korea ahead in wireless services to the point where both 3G and associated services (such as data, applications and handsets) from South Korea lead throughout the world.

In our discussions with vendors and operators, there appears to be levels of disconnect within the industry that regional and national wireless associations can address.

- Small to mid-sized wireless companies in Canada have limited visibility of market opportunities and global competitors.
- Wireless companies complain of little opportunity in Canada, as Canadian operators prefer to buy from bigger established names, or are not ready to deploy.
- There is a lack of active participation by operators in wireless clusters.
- Wireless companies complain of having difficulty securing funding for technology development and commercialization. This is in contradiction to Canada's high access to capital rating

If we are to take South Korea as an example, the framework includes regulatory bodies demanding advancement in technologies and vendors and operators working together to implement new technologies. For this model to be possible in Canada, operators would need to be aware of, and to a certain degree invested in, new technologies, not only available technologies but also those in development. To achieve this, operators should also be able to benefit from the export of commercialized technologies. To make this possible, operators may have to look at new or innovative business models that separate the network from services and leverage their venture funding.

Vendors seem to need greater access to capital to invest in R&D and partnerships with vendors would facilitate this. Close working relationships with operators that include investment will create pressure: on both sides of the value chain; for R&D; and for

commercialization. The drivers for this kind of environment are high levels of saturation and competition, outside threats to the status quo and a commitment from government and regulatory bodies to set and reach goals within the wireless sector. Canada is reaching saturation points in some parts of the country, but has yet to reach the level of competition found in highly competitive markets of Europe or Asia-Pacific. The point in the value chain where Canada is most challenged is in commercialization and to some extent, R&D. By bringing together operators and technology companies, promoting commercialization, increased investment and support in the R&D sector will naturally follow.

Wireless clusters and associations are in the position where they can bring together Canadian technology companies and operators, educating them on the technologies developing within Canada, the needs of commercialization and facilitating collaborative interaction. This will strengthen the commercialization level of the value chain, with spillover benefits into R&D investment.

Wireless clusters and associations are also in the position to be both a portal and a lobbyist for the wireless industry, to the investment community and to regulatory bodies. To the investment community, they can increase access to capital by providing market data and assessments that are beyond the means of small development vendors. To regulatory bodies, they can provide vision and planning to ensure that the policies in place develop Canada as a competitive force.

As a portal, the wireless clusters and associations become a first point of contact. This position can also be used to educate and facilitate exchange between wireless companies and the Canadian manufacturing and business communities, promoting the development of specialized solutions in situ, serving to add to the competitiveness of Canadian innovation, both wireless and not, and further increasing the level of incentive and investment in the wireless sector.

For clusters and associations to successfully develop their own levels of innovation we will require a level of visionary planning and cooperative synchronization among associations and clusters across the country.

Chapter

4

Part 3: Analysis of Market Shares and Market Trends

Global Wireless Ecosystem: Canada's Market Share

Canada represents a small part of the global marketplace. Using wireless voice and data spending as an indicator for comparison, Canada represents just over 2 percent of the total global market (see Figure 104).

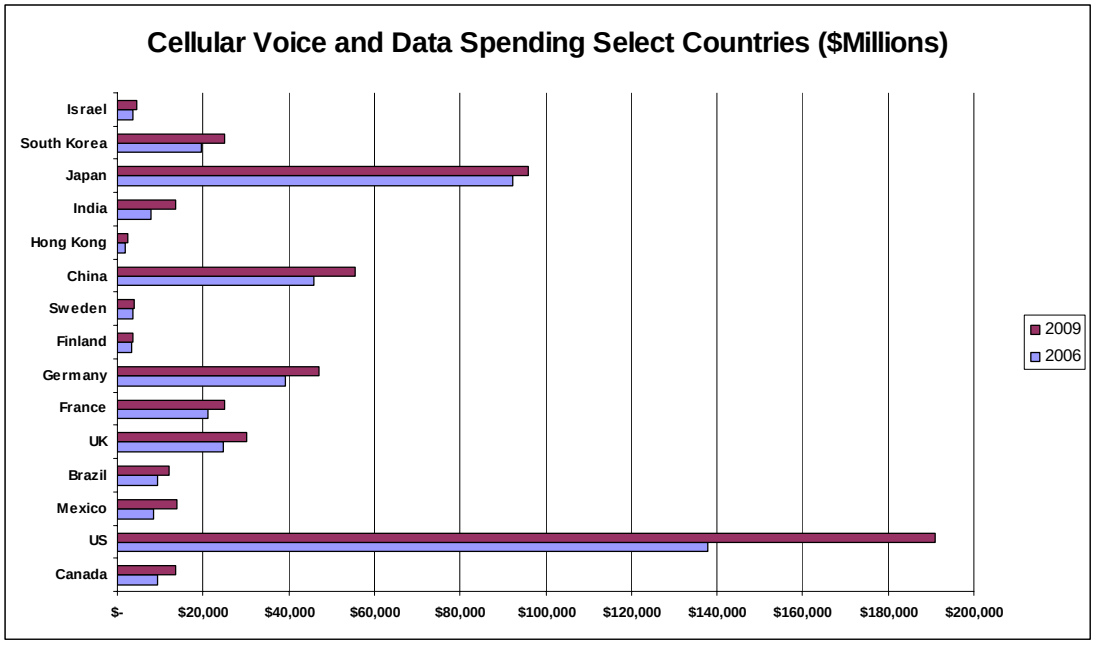


Figure 104 — Wireless Voice and Data Spending, Select Countries[132]

The Canadian market is a developing market for cellular, and according to IDC, it represents a 4 percent growth in cellular spend between 2006 and 2009. The US shows a similar profile as well, particularly in data. According to the same IDC projections, the US market represents 49 percent of the world growth in voice and data spending.[132] This bodes well for Canadian companies that can tap the US market with data applications, content and mobile platforms.

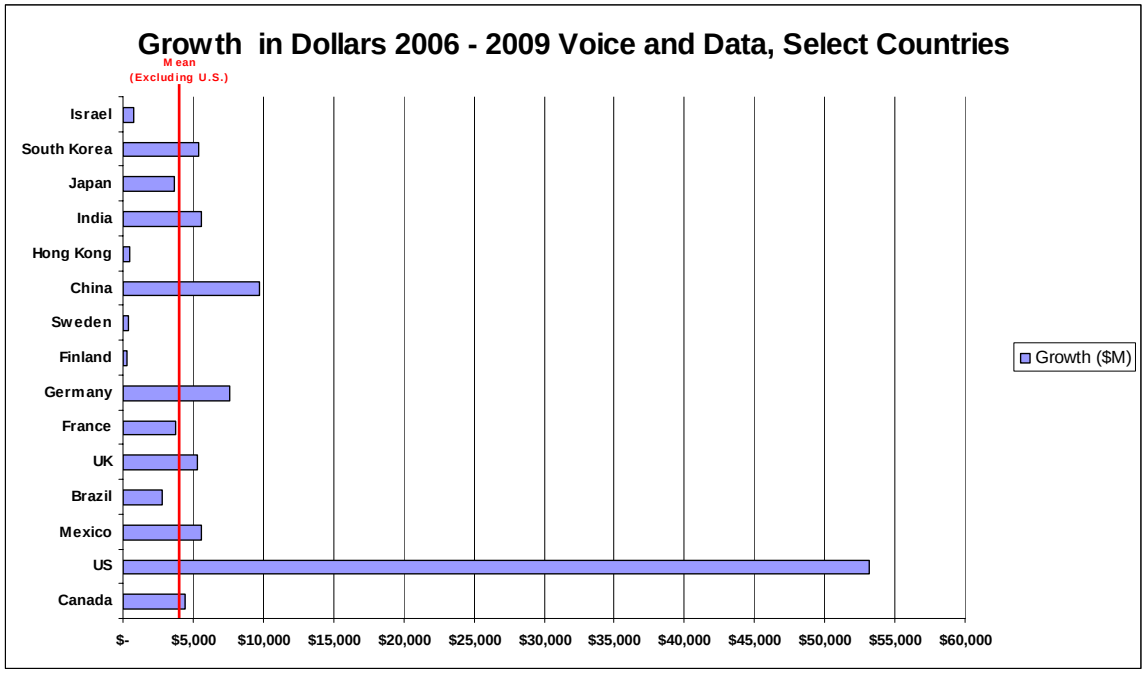


Figure 105 — Wireless Voice and Data Spending, Select Countries 2006-09, Growth in Dollars.[132]

Canada represents one of the highest GDP per capita ratings in the world (see Figure 106), but as a market is dwarfed by many countries with populations many times its size. Countries such as Finland, South Korea and Sweden are similar in size to Canada. As well, South Korea sits at the foot of the large advanced market of Japan, similar to Canada's proximity to the US market. By comparing the Technological Activity Index (see Figure 107) of these countries we find that Canada is rated high, slightly above South Korea and about 10 percent behind Finland and Sweden.

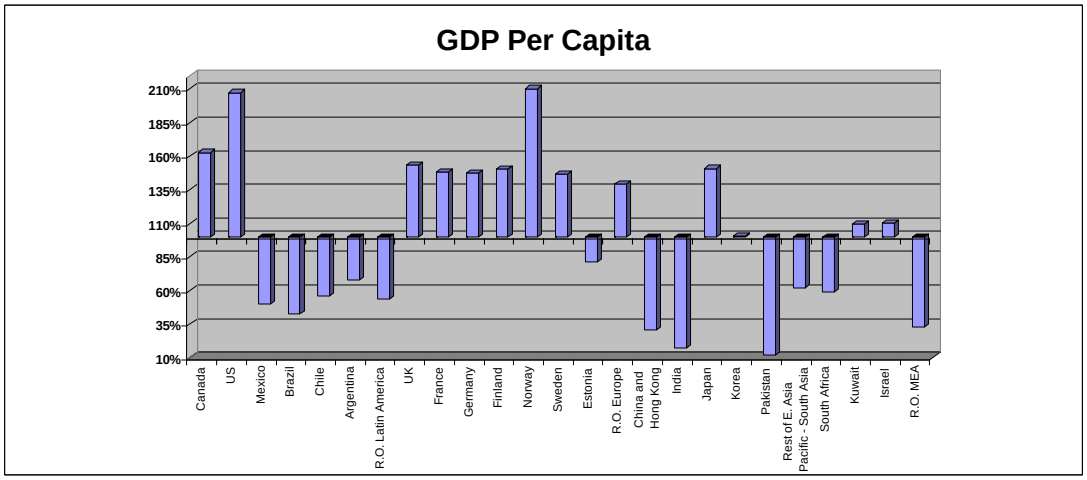


Figure 106 — Relative GDP Per Capita[144]

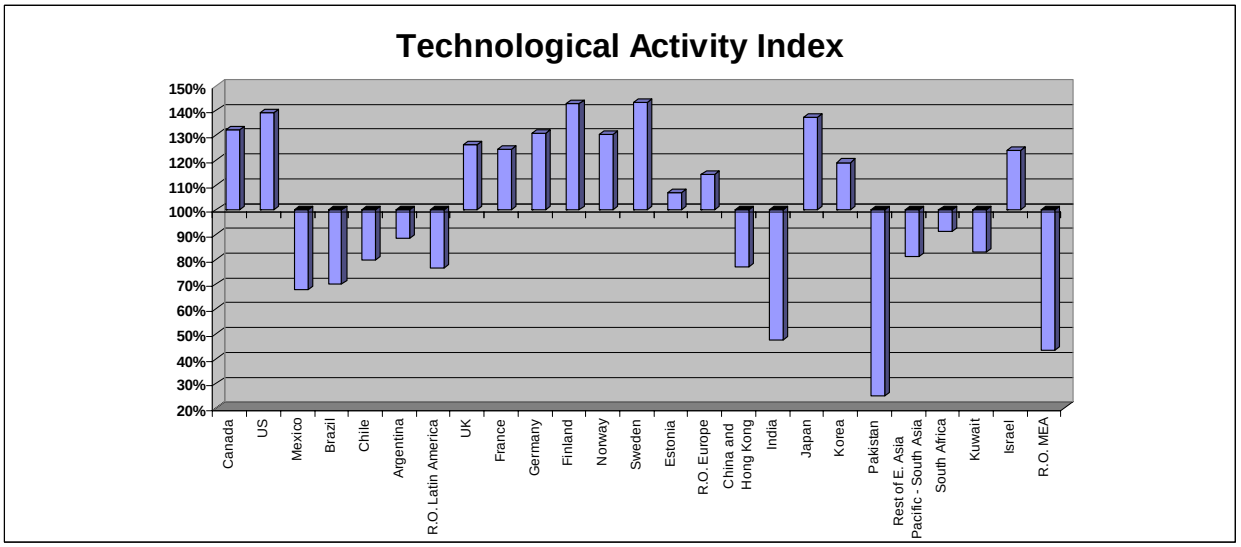


Figure 107 — Relative Technological Activity Index 2001[145]

On the Human Capital Index (see Figure 108), Canada rates relatively high as well, on par with the US and ahead of South Korea. Where there is significant difference is on the: R&D spending as percent of GDP (see Figure 109); high tech exports as percent of manufactured exports (see Figure 110); and total high tech exports (see Figure 111).

[144] Source: World Bank Global Indicators 2005, World Investment Report 2005.

[145] Source: UNCTAD, *World Investment Report 2005*, http://www.unctad.org/en/docs/wir2005_en.pdf.

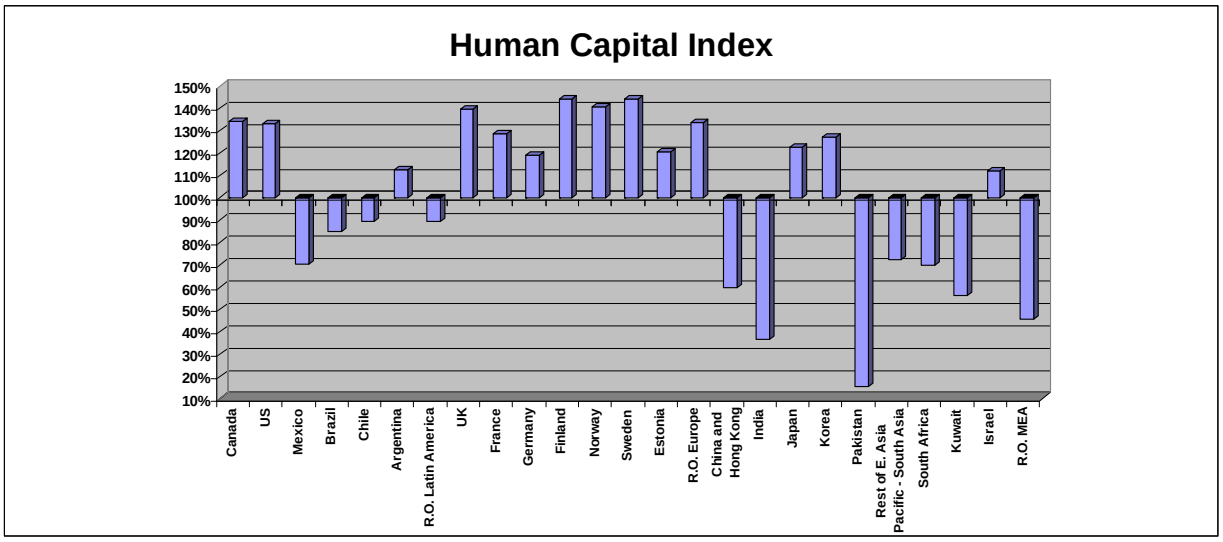


Figure 108 — Relative Human Capital Index 2001[145]

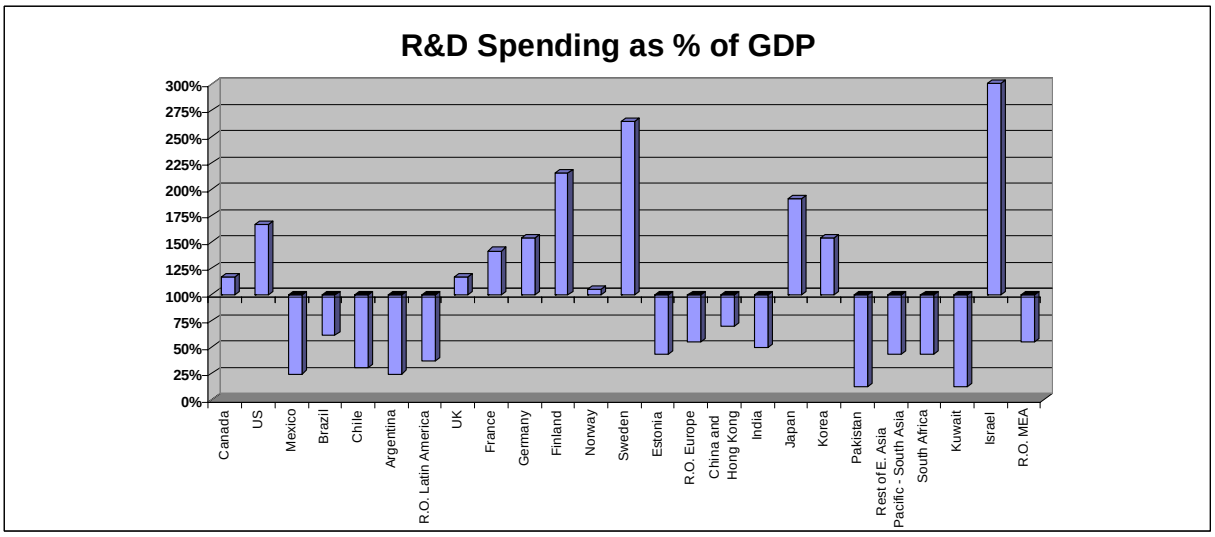


Figure 109 — Relative R&D Spending as percent of GDP[144]

As outlined and analyzed by Martin and Milway, despite having some of the most generous tax incentives for R&D (see Figure 93), Canada lags in R&D performance and output. They attribute much of this disadvantage, to the Canadian business environment not providing the competitive pressure required to stimulate advanced innovation. In our previous example, South Korea is a country that underperforms Canada in many respects, GDP per capita, human capital and technological activity, but far outperforms Canada on R&D spending and high tech exports. From Martin and Milway's analysis, the difference appears to be in the innovation demand pressure of the market, coming from both the market itself and through government intervention.

As a market in the global ecosystem, Canada has lagged many other highly developed nations. It has been slow to develop technologies in the local market despite much of the R&D of those technologies having high Canadian participation. Canada is poised for growth over the next few years, most of which will be catching up with more advanced markets and following suit with the US By investing in innovation at the business process level and developing original solutions to help advance the Canadian market, Canada has the potential to develop into a strong world market and strong world player — the success of which will depend on Canadian companies, the Government of Canada and the Canadian capital sector.

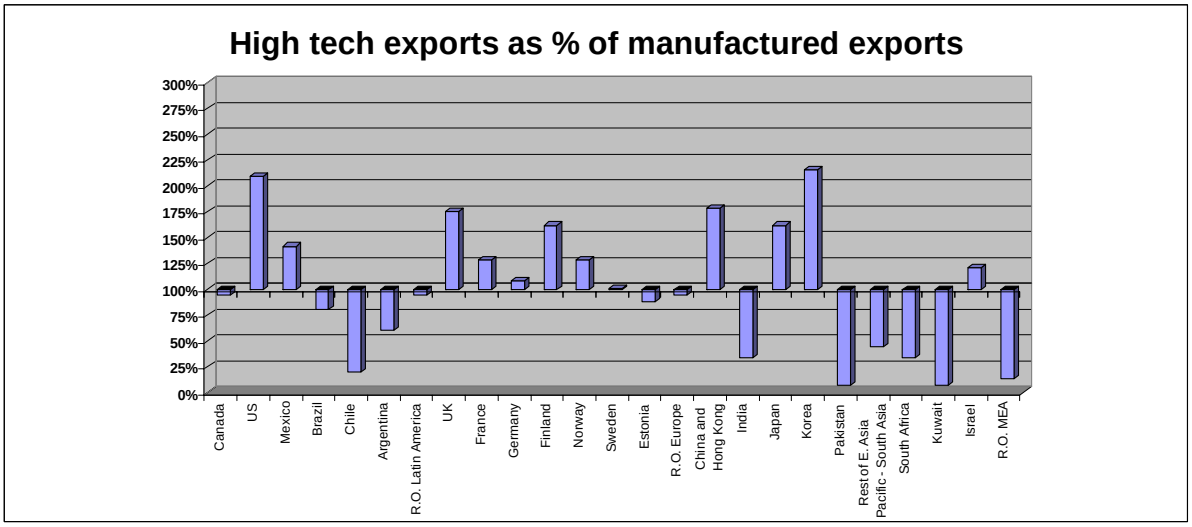


Figure 110 — Relative High Tech Exports as Percent of Manufactured Exports[144]

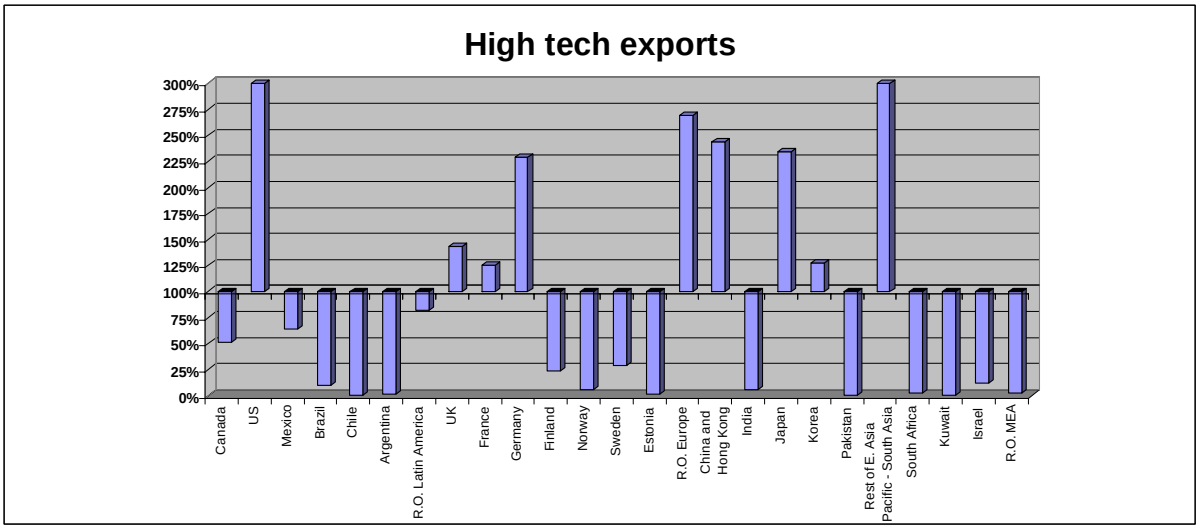


Figure 111 – Relative Total High Tech Exports[144]

Canadian Companies' Market Share of Wireless Industry Subsectors

Cellular Infrastructure

Nortel offers infrastructure solutions in both the GSM and CDMA market and has significant market share in both markets. According to Nortel, it has the 2nd largest market share in the CDMA infrastructure market,[146] second only to Lucent Technologies.[147] In the GSM market, Nortel lags in market share behind market leaders Ericsson, Nokia and Siemens. Nortel is also starting to face competition from vendors coming out of China like Huawei and ZTE. Nortel also has 3G products for CDMA2000 EVDO, WCDMA, and HSDPA.

Data Centric Devices and CPEs

RIM operates in a niche market providing push email solutions via its Blackberry™ devices and Blackberry Enterprise Servers (BES). According to a 2006 Gartner report on PDA shipments - based upon PDA vendor shipment estimates worldwide and excluding Smartphones — RIM saw its share of the PDA market go up four points from 17.4 percent in 2004 to 21.4 percent in 2005.[148] RIM was able to take market share away from Palm who saw its market share drop from 29.8 percent in 2004 to 18.6 percent a year later. RIM, however, faces increasing competition from PDA and Smartphone manufacturers and Microsoft who holds the largest market share in the PDA operating system market.

Sierra Wireless is another Canadian company that leads the market in offering cellular AirCards. Sierra Wireless has been able to expand its share of the world market by establishing an office presence in Latin America, Europe and Asia-Pacific.

Mobile Data

Canadian companies face challenges in developing and exporting content to mobile markets outside of North America. One reason identified by Canadian content providers, when interviewed by KAZAM, is that Canadian operators have adopted a cautious approach for bringing new content and services to market. An area of concern in the Canadian mobile content industry is the uncertainty around the regulatory aspect of mobile content in Canada. A case in point is the CRTC's review of mobile TV content,[149] and ruling on whether it should be exempt from

[146] David Murashige: *This Way Up, Nortel Wireless Update*: September 2005: http://www.nortel.com/corporate/investor/collateral/bofa_q3_2005_v2.pdf.

[147] Source: Dell'Oro Group: Mobility Infrastructure Market Revenues Climb 29% in 2004, February 2005, http://www.delloro.com/news/2005/Mob021605.htm.

[148] Source: Gartner: *Gartner Says Worldwide PDA Shipments Reach Record Level in 2005*, February 14, 2006, http://www.gartner.com/press_releases/asset_145348_11.html .

[149] Source: Blake, Cassels & Graydon LLP, *Mobile TV — Will The CRTC Exempt Mobile Broadcasting Services From Regulation?*, Blakes Bulletin on Communications Law, December 2005.

regulation. Some in the industry believe that, regulated mobile TV will mean higher access fees, which may hamper adoption rates of the service.

Canadian companies are strong in enabling mobile data deployment and content aggregation. Companies like OZ Communications are leading the way to enable instant messaging on mobile handsets and have sold their mobile IM solution to AOL and Virgin Mobile in the US, as well as Telefónica Móviles of Spain. Canadian content aggregators of note, include, AirG, Airborne and MyThum Interactive. AirG works with 85 operators worldwide who serve 90 percent of the US market, 65 percent of the European market and 70 percent of the Asia-Pacific market.

Enablers and Middleware

With the evolution of cellular networks towards packet switched data and enhanced bandwidth, the market for IP infrastructure and service enablers will grow. On the IMS (IP Multimedia Subsystems) side, Nortel has an IMS solution that is currently being trialed by Verizon Communications in the US. Nortel also has a globally established installed base of cellular equipment to leverage in order to evolve and grow those existing networks to IMS/MMD compliance over the next several years. They also have the ability to leverage installed base to sell packet data and data service enablers into emerging markets. Selected North American and European operators, when surveyed by KAZAM, have classified Nortel's IMS solution as strong. Convedia is a Canadian company that offers IP-based multimedia servers and has been successful in selling its products to operators in different regions around the world, including China Mobile, China Unicom and Telefonica. Airwide Solutions offers service enablers for messaging and has sold to over 70 operators, including Vodafone, in 46 countries around the world. Redknee is another Canadian company that has enjoyed success internationally and has products that are prevalent in the European markets with operators such as Vodafone, O2, Orange and E-plus Inc. Other Canadian companies with significant presence in the Cellular Enablers sector include Bridgewater Systems and Blueslice Networks Inc.

WiMAX

Since WiMAX products are in the midst of product certifications, we will see some network deployments happen at the end of 2006 and accelerate over the next few years. Alvarion, a Tel Aviv based company, was leading the BWA market with pre-WiMAX solutions. However, Canadian companies such as Redline Communications will be able to secure sizeable market share after having their base station and CPE equipment WiMAX certified already. Canadian companies also have the edge in the WiMAX market with their OFDM WiMAX products.

WiFi Mesh

The largest market shares in this industry are held by the likes of Motorola Canopy, Tropos Networks, Strix Systems and Cisco Systems. However, Canadian companies like Nortel and BelAir Networks have established markets for themselves. Nortel is known for deploying Mesh Networks in settings like university campuses whereas BelAir focuses on developing solutions that are

operator specific. Unlike municipalities or university campuses, operators require mesh network solutions that are dependable and provide consistent QoS (quality of service), allow for billing and provisioning and have built in redundancy. All these elements drive the total cost of the network higher and this is the market that BelAir Networks caters to.

WLAN (WiFi)

This is a technology area where opportunities exist for Canadian companies to develop further, as the WiFi market is large and will continue to grow. Cisco Systems, Inc, Aruba, Trapeze Networks and 3Com Corporation lead the market for WiFi Access Points (AP), whereas Linksys, D-Link, NETGEAR and Buffalo Technology Wireless lead the market for CPE's such as WiFi cards. Canadian companies are highly under-represented in this space when it comes to WiFi gear.

RFID

The presence of EPCglobal Canada and the establishment of a Canadian RFID Centre will foster the growth of Canadian companies dealing with RFID Tags and Readers. There are several companies currently involved in this market but most tend to partner with the larger players in the RFID market such as Intermec Technologies Corporation and Symbol Technologies. A strong area of growth in the RFID market is professional services for the integration of new RFID systems with legacy systems and processes. Canadian companies are strong in helping deploy, integrate and manage RFID solutions, with Bell Canada and CGI playing a role in systems integration while competing with the likes of IBM and Accenture.

Outlook of the Global Wireless Ecosystem and Sources of Competition

According to KAZAM, the global wireless industry including cellular infrastructure, mobile handsets, mobile data, RFID, Wireless Mesh and WiMAX will be worth approximately $300B by 2006 and grow at a CAGR of over 10 percent to nearly $400B by 2009. For the cellular industry, revenues from the sale of cellular infrastructure and handsets will be over $180B by 2009, whereas voice[132] and mobile data revenues will exceed $675B by 2009. Excluding voice revenues, cellular infrastructure spending, handset sales and mobile data service revenues will be in excess of $380B by 2009.

KAZAM estimates that the mobile data market alone will be worth just under $200B in 2009. The mobile handset market will hold the second largest market share at about 35 percent, with almost $140B in revenues by 2009. The third largest market share will be held by the cellular infrastructure industry, which will be worth approximately $50B by 2009.

The massive size of the global cellular industry will be driven by more than two billion cellular subscribers worldwide in 2006. This subscriber base is expected to increase to just over three billion by 2009. As the industry grows, we estimate that the mobile data market will experience over 80 percent of the new revenue growth between 2006 and 2009. The new revenues in the mobile data market will come from the deployment and adoption of new content and applications such as mobile TV, mobile broadcast, video and instant messaging, games, Push-to-Talk (PTT), premium messaging via mobile marketing and presence-based services. The move by operators towards IMS/MMD for an IP core will enable new IP-based services such as video conferencing, which will create new revenue streams.

Cellular operators face a clear threat from MVNOs that can offer cellular service to target segments, thereby offering more applicable and attractive mobile content and data services. Powerful brands such as Virgin, Disney and ESPN are well recognized and offer cellular users a differentiated service. IDC expects MVNO service subscribers, in Western Europe, to grow from 13 million in 2005 to 47 million in 2009,[150] representing a CAGR of 38 percent, whereas the CAGR of MNO based cellular subscribers in Western Europe will only be 2 percent only.

[150] Source: IDC Press Release, *3G Will Provide Opportunities for MVNOs in Western Europe, Says IDC*, June 2005, http://www.idc.com/getdoc.jsp?containerId=pr2005_06_15_110359.

Growth in cellular infrastructure over the next three years will mostly come from emerging markets including India and China. KAZAM expects downward pricing pressure on both infrastructure and devices as China, India, Russia, Brazil, and countries in the MEA region expand or grow cellular networks. The relative success of emerging vendors from China (ZTE and Huawei) in global markets over the last several years, and the inherent needs of emerging markets for lower costs provides for competitive pressures on Canadian vendors.

Some larger markets also have present differences in their preference for standards. For instance, China will deploy TD-SCDMA in addition to WCDMA and CDMA2000 for 3G. Korea has already deployed WiBRO and DMB for WMAN and mobile broadcast services. Canadian firms would be best to partner with local vendors, much like Nortel has done recently, in order to support the international market needs, which are different from the mainstream.

After the cellular industry, KAZAM estimates that WiFi will be the largest market shareholder with revenues of $3.6B in 2006 growing to $6.1 in 2009 at a CAGR of 20 percent. The remaining market share will be held jointly by RFID, Mesh Networks and WiMAX with combined revenues of $3B in 2006, which will grow to almost $8B by 2009 representing over 2 percent market share.

KAZAM estimates that Wireless MAN and BWA technologies will have the highest growth rates as WiMAX and WiFi-based Mesh Networks will both experience CAGR's of over 95 percent between 2006 and 2009. This robust growth can be attributed to two main factors. One factor is the market for both technologies is in the early stages and will therefore experience exponential growth over the next three years as technology adoption reaches a critical mass. The second factor is the demand for broadband connectivity to the Internet is growing and this will drive the adoption of technologies that facilitate wirelessly connectivity to the Internet in both rural and urban areas around the world.

Even though WiMAX and Mesh Networks are competing technologies to a certain extent, they are unique. WiMAX deployments are expected in the licensed band for the most part, however, WiMAX can also be launched in the unlicensed band. While wireless Mesh Networks would require several base stations to form a mesh to cover the same area as that of a single WiMAX base station, they operate in the unlicensed spectrum and utilize the largely prevalent and inexpensive WiFi CPEs. WiMAX is primed for use as a last mile access and backhaul solution due to its ability

to service larger areas than a traditional WiFi Access Point (AP). Mesh Networks will be more effective in urban areas where the density of users is greater in a given geographic area. This will allow service providers to reduce the cost of the overall network as fewer AP's and backhaul nodes are required and service providers are able to effectively monetize their network.

Another hurdle that WiMAX faces is CPE costs relative to WiFi CPEs, which cost significantly less because of economies of scale due to mass adoption. This is not the case for WiMAX. In an article published by the BBC, Scott Richardson, general manager of Intel's broadband wireless business, is quoted as saying that WiMAX CPE costs were too high to expect mass adoption and unit CPE prices needed to drop to sub $200, from the present $300 to $500 unit price, to drive adoption.[151]

One thing that both technologies have in common is the fact that they can open the market to non-traditional broadband service providers taking business away from the incumbent telcos. The city of Fredericton is a prime example of this. The Fred-eZone was launched back in November 2003 and is enabled by a fibre optic network, a Motorola Canopy network and over a hundred access points supplied by Cisco Systems, Inc. There is no cost to the WiFi service and there are plans to expand the service to cover all the business parks in and around Fredericton. Other municipalities have already followed Fredericton's example and are offering either free or pay-per-use WiFi service. These municipalities are effectively taking business away from the local telecom service providers by turning into ISPs (Internet service provider).

Timing for WiMAX mobility support is also a consideration, with the initial entry of HSDPA into the market. While HSDPA is still in its early stages, with limited handset availability, there is a chance that over time, HSDPA will impact the deployment of mobile capable WiMAX 802.16e in some markets. At the 3GSM World Congress in Barcelona, Spain in 2006, Arun Sarin, CEO of Vodafone Group, commented in his Keynote Interview that Vodafone feels that mobile Internet deployments should be supported using HSDPA rather than 802.16e. This doesn't totally discount 802.16e, however, it does underline the competitive threats from new technologies on one another and the importance of timing and availability of cost effective devices.

[151] Source: BBC News, *Intel reveals WiMAX wireless chip* April 2005, http://news.bbc.co.uk/1/hi/technology/4455727.stm.

KAZAM estimates that the market for RFID tags and readers will grow to $3.7B in 2009. RFID tags are expected to replace the traditional bar codes that have been used in manufacturing and logistics industries for the past several years. EPCglobal is a consortium of major manufacturers, retailers and pharmaceuticals that is driving the RFID market by enforcing electronic product code compliance from suppliers.

The US Department of Defense will be another major driver for the RFID market as it looks to improve the efficiency of its supply chain. As of November 2005, the DoD is asking some suppliers awarded with new contracts to RFID to enable their products. The DoD has a staggering number of suppliers estimated to be around 60 000.[152]

Many retailers around the world will be looking to follow the examples set by companies, such as Wal-Mart, as RFID can help in streamlining costs associated with the supply chain in a retail environment.

[152] Source: CCM SelectInvest, *RFID: It's in the army now!* December 2005: http://www.ccmsectorinvest.com/detailednews.asp?intReleaseID=9032&d=12*2005&n=36.

Outlook of the Wireless Industry Sub-sectors

Outlook for Cellular Infrastructure Spending (2.5/3G Networks)

The Canadian cellular market is expected to hit approximately 18 million subscribers by the end of 2006 and grow at a CAGR of nearly 7 percent to 22 million subscribers by 2009.[153] In late 2005, Canadian operators began rolling out 3G networks with rollouts expected to continue over several years. Spending on cellular networks in North America will top $10B by the end of the 2006 and decrease at a CAGR of -2 percent by 2009[141]. Despite an overall drop in cellular infrastructure spending, investment in EVDO, Evolution Data Voice (EVDV) and UMTS-HSDPA networks will be strong over the next four years. Bell Mobility and TELUS Mobility have already announced plans to rollout EVDO networks. Rogers Wireless announced on February 13th 2006 that it had awarded Ericsson Canada the contract to upgrade its GSM network to UMTS-HSDPA indicating that the market for 3G networks in Canada is at its early stages and will grow strongly over the next few years.

The cellular infrastructure market will see spending in two key ways. The first is through the upgrade of networks in developed markets in Western Europe, North America and parts of Asia-Pacific to 3G and next generation networks including EVDO, EVDV, CDMA2000 nX, and WCDMA. Given that the majority of the world's cellular market utilizes GSM technology, WCDMA or UMTS infrastructure spending will be higher than spending on EVDO and EVDV or CDMA2000 nX. The second form of spending will come from emerging markets such as India, where current coverage is about 22 percent of the population (unlike China, which is closer to 97 percent), however, most emerging markets in Asia and MEA have significantly lower ARPUs, and resulting high sensitivity to infrastructure costs.

Outlook for Cellular Devices

Despite the fact that handset shipments are expected to grow at a CAGR of 5 percent between 2006 and 2009, revenues from handsets will grow at a CAGR of 2 percent according to KAZAM. This will be a result of downward pressure on handset prices due to overwhelming demand for sub $50/$30 handsets from developing countries globally. This will drive average handset prices from $140 to $127. This will be somewhat offset by the increase in sales of high tier mobile devices supporting 3G services and smartphones. The growth of handset shipments globally will be a result of two factors. One factor is that developing countries will experience tremendous growth in cellular

[153] KAZAM Cellular Subscriber Forecasts, 2006.

subscribers, more so than developed countries, whose markets will become saturated. The second factor is that replacement sales of handsets will keep the demand for cellular devices high in mature markets.

In developed and mature markets, replacement sales will drive the handset market as subscribers upgrade to smartphones and handsets with enhanced capabilities for video services and music playback. This creates an opportunity for companies like RIM to capture the market share. As higher speed networks including HSDPA are rolled out in these markets, there will be increased demand for wireless AirCards, which presents opportunities for companies like Sierra Wireless to secure market share.

Outlook for Mobile Data

Globally, the largest market for mobile data is by far Asia-Pacific, with a dominant market share of nearly 50 percent by the end of 2006. This dominance of the mobile data market stems from having some of the largest and most advanced markets in the world including countries like China, Japan, India and South Korea. Within the Asia-Pacific mobile data market, Japan has the largest share with the mobile data market. Apart from South Korea, Japan is the only country in the world where messaging revenues are significantly lower than information and entertainment services. This can be attributed to the popularity of platforms such as NTT DoCoMo's i-mode and Vodafone's Live!, which allow users to surf the Internet, check email and conduct video calls. Additionally, subscribers with compatible handsets can use their devices as wallets, keys and transit passes.

After Asia-Pacific, Europe and the US will have the largest market shares for mobile data. While Asia-Pacific and Europe will lose some market share by 2009 to Latin America and MEA, the US will increase its share of the mobile data market. The increase in market share will be fuelled by growth in messaging from applications such as premium SMS and video messaging as well as information and entertainment services. Mobile workers will drive information service spending higher whereas the introduction of entertainment services such as mobile TV with applications such as video on demand (VOD) will drive this segment of mobile data revenues higher.

As cellular subscribers grow in the developing regions of Latin America and MEA and move beyond voice connectivity they will drive mobile data revenues higher with spending on messaging leading the way.

Outlook for WiMAX

The nearly 100 percent year over year growth of WiMAX will be a result of extensive network rollouts in areas with tremendous demand for BWA and places where WiMAX

will serve as a last mile access solution. The tremendous growth will also be fuelled by the availability of cheaper CPEs and the retail of WiMAX-enabled devices such as laptops.

The Government of Canada has awarded over 30 licenses for BWA in the 3.5 GHz spectrum. Licensees include both traditional operators and non-traditional telecom service providers. WiMAX threatens to change the business model for offering broadband services as ISP's will no longer require a network, aside from a backhaul link, to offer services to their clients. This shift in business paradigm will be disruptive, for incumbent wireline telcos, as institutions like municipalities will now have the ability to offer wireless broadband services.

The recent ratification of the mobile WiMAX standard will push vendors to develop products for certification. Once the mobile version of WiMAX is available, sometime in late 2007, and networks are rolled out, cellular service providers will experience a threat to their business model.

Broadband penetration rates in both Canada and the US are below 20 percent according to the OECD Broadband Statistics published in 2005[154] with Canada at 19.2 percent and the US at 14.5 percent. With low penetration, the broadband market in both countries still have a lot of room for growth and WiMAX will boost the number of broadband subscribers in both countries.

Outlook for WiFi Mesh Networks

According to KAZAM, the global Wireless Mesh Network market is expected to reach $130M by 2006. This will be driven by WMAN network deployments such as the country wide — 1200 square mile — WiFi Mesh Network in the Republic of Macedonia and in cities such as Philadelphia and San Francisco (despite attempts to block by incumbent telcos). The global market for Mesh Networks will be worth $976M by 2009 growing at a CAGR of 96 percent.

Mesh Networks compete with WiMAX to some extent however unlike licensed WiMAX deployments, Mesh Networks operate in the unlicensed band. This significantly reduces the total start-up cost, as no licensing fees have to be paid. Wireless mesh uses existing WiFi CPEs, which drastically reduces the cost for end users.

Growth in Asia-Pacific will be driven by the connectivity needs of large urban cities in countries like India and China. Growth in North America will come from the rollout of WiFi Mesh Networks in more cities throughout the region. In North America, the US has

[154] Source: OECD, *Broadband Statistics, June 2005*, http://www.oecd.org/document/16/0,2340,en_2649_34225_35526608_1_1_1_1,00.html.

led the way in MAN rollouts of Mesh Networks. Several Canadian cities have either deployed wireless mesh or plan to do so in the next year. These include Fredericton, Calgary and Toronto.

Outlook for WLAN (WiFi)

The universally popular enabler of wireless broadband, WiFi, has come a long way from its early days. Despite operating in the unlicensed band, and being prone to interference, growth in adoption of WiFi has been stellar. By KAZAM estimates, the global WiFi equipment market will exceed $3.6B by 2006 and grow at a CAGR of 20 percent to $6.1B by 2009.

Our estimates indicate that the Asia-Pacific market will increase to 50 percent by 2009, as developing countries in this region deploy infrastructure required to offer broadband services.

KAZAM believes that the North American market is the second largest market today, diminishing slightly to 23 percent by 2009. The decrease in market share will be a result of increased broadband usage in the developing regions around the world. WiFi adoption has been strong in the North American market by both enterprises and consumer market segments and the demand for mobile connectivity has lead to market growth. By KAZAM estimates, despite the loss in market share, CAGR between 2006 and 2009 will remain strong at 17 percent. Competing wireless broadband technologies such as WiMAX and 3G networks will ensure that the growth rate stays below the global average CAGR of 20 percent.

Europe will hold the third largest market share, remaining steady at 23 percent by 2009. The majority of growth will come from Eastern Europe, where broadband penetration is low presently, as it tries to catch up to Western Europe.

Latin America and MEA lags the world in WiFi adoption, and as infrastructure is put in place, broadband subscribers will increase steadily.

Outlook for RFID

The US is largely responsible for the significant market share held by North America. Both the US Department of Defense and large retailers like Wal-Mart are driving the market for RFID tags and readers. The EPC (electronic product code) Global Consortium, which ratified the RFID Generation 2 standard, is headed by US-based giants such as Wal-Mart, Procter & Gamble, Lockheed Martin, and Johnson & Johnson is also driving the RFID market.

Europe, specifically Western Europe, and Asia-Pacific will also drive the market for RFID. Many of Wal-Mart's suppliers are based in the Asia-Pacific market and its largest

suppliers have already started complying with Wal-Mart's request to RFID-enable their products.

KAZAM believes that the growth in demand for RFID professional services will outpace growth in the RFID tags and reader market as more companies look to RFID enable their supply chain.

Chapter

5

The Canadian Wireless Industry: Key Challenges and Next Steps

Introduction

KAZAM's Wireless Industry Value Chain maps the wireless industry in stages, showing how each stage feeds and supports the next. The Canadian Wireless Industry has various strengths and challenges throughout the value chain and challenges at any stage can limit the potential and hold back the advancement of the entire value chain. This overview identifies the key challenges found in the Canadian value chain, examines the components of those challenges, and outlines the steps required to address those challenges.

For comparison, we compared Canada with the US, Canada's major trading partner and closest market, and South Korea, a country showing tremendous leadership in the wireless sector in both technological advancement and international export.

Overview of Indicators and Challenges

1. Canada has taken a leadership role in technology development but does not seem to hold onto its leadership position consistently. Canada was ranked third among OECD countries for technological activity in 1995. By 2000, Canada was ranked ninth, behind countries such as Finland, Sweden and Norway. Similarly, for broadband penetration, Canada used to be second only to South Korea, and as of December 2005, the OECD reports Canada to be ranked number eight in the world.

2. Canada is relatively low in high tech exports as a percentage of manufactured exports, trailing South Korea by 79 percent, the US by 74 percent, but on par with the EU average of 14 percent. Canada rates low in overall in high tech exports, trailing South Korea by 42 percent, and the US by 131 percent.

3. Canada is low in R&D as a percentage of GDP, trailing South Korea by 26 percent, the US by 34 percent, and the EU average by 13 percent, despite one of the most generous R&D tax incentive programs worldwide.

4. Canada is behind in technology deployment, estimated at 6–12 months behind European markets, 12–18+ months behind Japan and South Korea, and approximately six months behind the US on average.

Challenges and Next Steps

1. Difficulty Maintaining Leadership Position

- Canada has fallen behind in technological activity ratings
    - The level of activity has not necessarily dropped, but the level of activity exhibited by other countries has dramatically increased.
- Canada was the first in North America to establish inter-carrier SMS, MMS and short codes
    - Canada has been very slow to fully monetize these platforms with advanced services such as premium SMS as an example. This can also be applied to the monetization of other enablers including LBS, etc.
- Canada was a leader in broadband penetration and services such as e-government
    - Other countries, including Finland, the Netherlands and Switzerland, have caught up to and surpassed Canada in the broadband space, promoting advanced services, advanced connectivity and developing indigenous e-services.

Result

For some emerging technologies where Canada has had leadership, such as in broadband and e-services, historically, Canada has acted as an evangelist for these technologies, but often has not benefited directly.

Next Steps

- The role Canada has played, evangelizing new technologies, has pushed new technologies and new ideas forward worldwide. Future activities should be planned with the promotion and inclusion of Canadian companies as a focus and with specific targeted sales as a goal.

- As most innovation companies are SMEs, a focused program of joint efforts and cooperative alliances by Canadian companies and the Canadian government, to address specific topics and issues in specific countries (with an end goal of sales rather than just market education) should be considered.

2. Low in High Tech Exports

- Export of innovation requires resources for commercialization
    - Most innovation companies in Canada are SMEs with limited resources.
    - Export often requires local presence, investment and long sales cycles.
- Export of innovation requires reference clients, proof of concept and resources
    - Opportunities for commercialization of new technologies and innovation in Canada are limited in the wireless sector.
    - Innovation companies forced to go to international markets for reference clients.
    - Most innovation companies in Canada are SMEs.

Result

Less Canadian innovation is exported or is ready for export.

Canadian innovation becomes an attractive target for foreign acquisition.

Next Steps

- Consideration of incentives for larger Canadian companies to partner with smaller Canadian companies, and for operators to adopt emerging Canadian technologies and partner with Canadian innovation companies.
- Consideration of extending tax incentives beyond R&D to the commercialization stage and towards business process improvement.
- Consideration of more extensive international business development programs designed for SMEs that focus on identifying qualified sales leads and opportunities, including the tracking of Request for Proposals (RFPs) from international markets.

3. Low R&D Spending as Percentage of GDP

- High availability of capital, low pressure for investment capital to perform
    - Current structure of LSIF do not require high returns from innovation and do not support commercialization.
- Operators take a "fast follower" approach to new technology deployment
    - "Fast follower" approach limits local deployment of advanced technologies, limiting demand for innovation and in turn, R&D spending.

Result

R&D spending as a percentage of GDP trails South Korea by 26 percent

Despite incentives and availability of capital, companies could be driven to produce more R&D by increased demand and more opportunities to commercialize and establish reference clients in the local market

Next Steps

- Consideration of extending LSIF to commercialization.
- Consideration of incentives to establish new technologies in the Canadian marketplace at early stages of development.
- Consideration of incentives and LSIF extension to business process improvement and technology adoption.

4. Lagging Deployment of New Technologies

- Canadian managers tend to be less educated that US counterparts
    - More education among managers tends to drive innovation adoption, commercialization of new products and innovation in business processes and commercialization.
- Canadian cellular operators have traditionally taken a fast follower approach
    - Fast follower approach makes strong business sense for operators but slows the commercialization step of the value chain.
    - Waiting for demand and market conditions to be ideal.
- Canadian cellular operators have been slow to monetize existing platforms, i.e. advancing SMS to premium SMS
    - Rapid monetization of technology is not the sole responsibility of operators, includes others in the value chain including regulatory bodies
        - in the case of mobile data services, content and applications, operators, content developers and providers, as well as regulatory policy all play an important role

Result

Canadian innovation companies are often forced to go to international markets to trial and launch products.

Canadian innovation companies require more resources to enter international markets without reference clients.

Operators take a "safe" approach to technology deployment, limiting local market deployment of new technologies.

There is relatively less pressure on innovation companies to perform as a result of relaxed funding requirements.

Next Steps

- Consideration of incentives to promote adoption of new technologies, particularly Canadian innovation.
- Consideration of incentives to advance existing technology investments.

- Consideration of incentives and funding for advanced managerial training and degrees.

- A more open and dynamic ecosystem for mobile content and applications is needed in Canada. In South Korea, operators and content providers share more revenues with content developers and aggregators; and invest in innovative content development companies. A conservative, walled garden approach also leads to limited access for consumers to content of interest, and to content providers who wish to attract users to their content through the mobile medium.

Chapter

6

Glossary of Terms

This glossary is compiled and adopted from Market Magic Research, Developing for 3G, April 2005, and made available to the Orange partner network.

1G refers to the first generation mobile telephony system (i.e. analog cellphones).
1xRTT (One times Radio Transmission Technology) is a US CDMA technology from QUALCOMM supports peak data speeds up to 144 kbps, and up to a doubling of voice capacity over normal CDMA networks.
2G refers to second generation mobile telephony (i.e. digital cellphones) but limited to circuit based data.
2.5G refers to 2G plus faster, always-on data services, which works in the background, and is also known as GPRS. Some will include EDGE in this category as well as CDMA 1x RTT.
3G refers to a third generation mobile telephony, generally refers to wideband mobile services and applications, which feature high, always-on data rates. The world has split into three, 3G camps: UMTS (WCDMA) in the GSM world; CDMA2000 in the non-GSM parts of the Americas, South Korea and Japan; and TDS-CDMA in the People's Republic of China.
3.5G refers to HSDPA and is an enhancement to WCDMA, which will bring even higher speed data.
3GPP (Third Generation Partnership Project) is a standards group set up to expedite the development of open, globally accepted, technical specifications for 3G specifically UMTS WCDMA. This group is made up of members of other standards organizations including ARIB, ATIS, CCSA, ETSI, TTA and TTC.
3GPP Release 99 is the first set of specifications released by the 3GPP for UMTS and IMT2000. The specification includes UTRA and the first set of UMTS services.
3GPP2 (Third Generation Partnership Project 2) is a collaborative Third Generation (3G) telecommunications specification project comprising North American and Asian interests on the development of the next generation CDMA2000 wireless communications. 3GPP2 is separate and independent of 3GPP.
3GSM is a name used for the WCDMA 3G standard backed by the GSM Association.
3GSP (3G service provider) refers to mobile operators that have 3G license to provide 3G services to customers.
4G refers to the fourth generation mobile telephony, which although today is conceptual, will one day become the successor of 3G. It is only conceptual and describes two

different but overlapping ideas; high-speed mobile wireless access with data rates of the order of magnitude the same as a local area network connection (10 Mbps and higher), and pervasive networks, in which a user can be simultaneously connected to several wireless access technologies and can seamlessly move between them. These access technologies can be WiFi, UMTS, EDGE or any other future access technology. Included in the 4G concept is software radio technology to build highly flexible mobile phones and the use of mesh routing protocols to create the pervasive network.

802.11 are a family of IEEE standards for wireless LANs with specs for 1, 11, 24, and 54 Mbps. 802.11 uses low cost access points, which typically covering 50 to 100 meters. 802.11 comes in different versions a, b, and g with a being the most common thus the g version (54 Mbps) is referred to as 802.11g. 802.11 uses do not require a license to use since it is based upon public frequencies.

802.11a is an amendment to the original IEEE 802.11 standard and uses the same core protocol as the original standard but operates in 5 GHz band, and uses a 52subcarrier OFDM (Orthogonal Frequency Division Multiplexing).It has a maximum raw data rate of 54 Mbps but in practice yields realistic throughput in the mid 20 Mbps.

802.11b is an amendment to the original IEEE 802.11 standard and has a maximum raw data rate of 11 Mbps and uses the same CSMA/CA media access method defined in the original standard. Due to the CSMA/CA protocol overhead, in practice the maximum 802.11b throughput that an application can achieve is about 5.9 Mbps over TCP and 7.1 Mbps over UDP. 802.11b operates in the 2.4 GHz RF spectrum. Hence, metal, water, and thick walls absorb 802.11b signals and decrease the range drastically.

802.11g is an amendment to the original IEEE 802.11 standard, this flavour works in the 2.4 GHz band (like 802.11b) but operates at a maximum raw data rate of 54 Mbps, or about 24.7 Mbps net throughput like 802.11a. It is fully backwards compatible with b and uses the same frequencies.

802.11 legacy is the original version of IEEE 802.11 it specifies two raw data rates of 1 and 2 Megabits per second (Mbps) to be transmitted via infrared (IR) signals or in the Industrial Scientific Medical frequency band at 2.4 GHz. IR remains a part of the standard but has no actual implementations.

802.11n refers to a new 802.11 Task Group (TGn) formed to develop a new amendment to the 802.11 standard for local area wireless networks. The real data throughput will be at least 100 Mbps (which may require an even higher raw data rate at the physical layer), and so up to 45 times faster than 802.11a or 802.11g, and perhaps 20 times faster than 802.11b. It is projected that 802.11n will also offer a better operating distance than current networks. There are two competing variants of the 802.11n standard; WWiSE (backed by companies including Broadcom) and TGn Sync (backed by Intel and Philips). The standardization process is expected to be completed by the end of 2006.

A

Access Point see AP.

Advanced Mobile Phone System see AMPS

ADSL (Asymmetric Digital Subscriber Line) is a form of DSL, a data communications technology, which enables faster data transmission over copper telephone lines than a conventional modem can provide. ADSL is a popular form of wired broadband and is used often with wireless technology such as WiFi.

AP (Access Point) is a device that connects wireless communication devices together to create a wireless network using WiFi or 802.11. The AP is usually connected to a wired network, and can relay data between devices on each side.

Air Interface denotes the specification for the radio transmission between base station and mobile phones. The Air Interface defines the protocol to be used including the

frequency or frequencies to be used, the bandwidth for the individual radio channels, and the encoding methods to be used (e.g. WCDMA, TDCDMA, CDMA2000).

AMPS (Advanced Mobile Phone System) is the North American analog cellular phone system or the 1G system used in the United States. AMPS uses the 800 MHz frequency band.

Analog refers to the technology, which until recently, was the norm for mobile phones, for example, 1G. It gives lower call quality and a major security risk. It is referred to as analog since the voice is carried as an analog signal on top of the Air Interface.

ANSI41 (also known as IS41 and TIA/EIA41) is a wireless intersystem protocol used for switch-to-switch and network-to-network coordination on certain 3G standards. The core network for CDMA2000 is based on the ANSI41 standard.

Antenna is the device used to transmit and collect the radio signals on a mobile phone or base station.

Application-Specific Integrated Circuit see ASIC

ARPU (Average Revenue per User) is a common business metric used by network operators to measure success. It measures the average amount of money that a customer will spend over a period of time on mobile phone services.

ARIB (Association of Radio Industry and Businesses) is a Japanese mobile standard setting body whose members are eligible to join the 3GPP and 3GPP2.

ASIC (Application-Specific Integrated Circuit) is an integrated circuit with functionality customized for a particular use rather than serving for general-purpose use. For example, a chip designed solely to run a mobile phone is an ASIC. In contrast, a microprocessor is not application-specific, because users can adapt it to many purposes.

Association of Radio Industry and Businesses see ARIB.

Asymmetric Digital Subscriber Line see ADSL.

Asynchronous Transfer Mode see ATM.

Asynchronous Transmission a mode to send data in which the sending and receiving parties know where a packet of data begins and ends because each byte is framed with additional bits, called a start bit and a stop bit. A start bit indicates the beginning of a new character; it is always 0 (zero). A stop bit marks the end of the character. It appears after the parity bit, if one is in use.

ATM (Asynchronous Transfer Mode) is a high bandwidth, fixed-size packet switching and transmission system for data. Because it uses fixed-size packets called "cells" it is sometimes called "cell relay." ATM is the basis for many fixed line broadband standards.

Auction refers to the process, which many national governments use to sell licenses for 3G. In the auctions, the licenses went to the highest bidders. Some European countries generated billions of dollars in fees through these auctions.

B

Bandwidth is the capacity of a transmission channel. Because capacity, or even maximum speed, is generally dependent on the frequency range available, bandwidth, the width of a frequency band has a close correlation with the maximum transmission speed available to a subscriber.

Base Station is on of the many fixed radio transmitters and receivers, which maintain the communications between the mobile telephone and the public system telephone network (PSTN).

Base Transceiver Station see BTS.

Binary Runtime Environment for Wireless see BREW.

Bit (Binary digit) is the smallest unit of digital information that a computer can process. A binary digit can only have one of two values usually indicated by "1" and "0."

Blog (also known as a weblog) is a web application, which contains periodic posts on a common webpage. These posts are often but not necessarily in reverse chronological order. Such a website would typically be accessible to any Internet user. The term "blog" came into common use as a way of avoiding confusion with the term server log.
Bluetooth is a global initiative by Ericsson, IBM, Intel, Nokia and Toshiba to set a standard for cable free connectivity between mobile phones, mobile PCs, handheld computers and other peripherals. Bluetooth uses short-range radio links in the 2.4 GHZ Instrumentation Scientific and Medical (ISM) "free band". Bluetooth was named after a Nordic King.
Bottleneck a capacity constraint that may limit traffic carried on the network during peak load conditions.
BPS (Bits per Second) is a unit of data transmission speed. It is the number of digital bits of information transmitted in a second.
BREW (Binary Runtime Environment for Wireless) is a QUALCOMM technology, which competes with Java and allows application developers to build programs, which end users can download to their mobile phones.
Broadband refers to the classification used for the group of communication channels, which have a bandwidth higher than about 2 Mbps.
Broadcast refers to the simultaneous transmission of data or voice to a number of stations or receivers.
Browser is a software package that enables a user to display and interact with documents hosted by web servers or WAP servers.
BTS (Base Transceiver Station) is the technical term for a mobile phone base station. A BTS contains the transmitter, the receiver, and the aerials or antennas to provide the air interface to a cell. Several BTS's are administered by a BSC (Base Station Controller), which is in turn is administered by an MSC (Mobile Switching Center).
Byte is an 8 bit unit of data, also called an octet.

C

Call Drop Rate is a measure of network quality. The percentage of calls dropped by the network out of the total number of completed calls. Sending Call Drop Rate is the percentage of calls dropped by the network out of the total number of sending calls. Receiving Call Drop Rate is the percentage of calls dropped by the network out of the total number of completed receiving calls.
Caller ID see CLI.
Caller Line Identification see CLI.
CAP (CAMEL Application Protocol) is the protocol used between two CAMEL Servers to ensure the proper roaming of value-added services.
CAMEL (Customized Application for Mobile Networks Enhanced Logic) Server is a network element, which ensures that the entire home environment including dialing short codes are supported when a GSM phone roams on a foreign network.
CAMEL Application Protocol see CAP.
Carrier is a company licensed to act as a network operator and to offer any number of communication services for voice and data.
CDMA (Code Division Multiple Access) is a multiple access technique, which uses code sequences as traffic channels within common radio spectrum. Under the CDMA access method, the spectrum is divided into wider frequency bands (1.25 MHz or more). All users communicate on the wideband simultaneously; however, they encode and decode their data using special codes, which are unique to the cell. Thus, each user is assigned a shared wideband frequency and a unique code on that frequency band. The

technology is the basis of QUALCOMM's cdmaOne (IS95) and UMTS air interfaces. Frequently confused with W-CDMA, here are a few quick facts to help out: CDMA the multiplexing principle of the W-CDMA air interface. The W-CDMA air interface is used in the global 3G standard, UMTS, and Japanese 3G standards, FOMA by NTT DoCoMo. The CDMA family of standards (including cdmaOne and CDMA2000) are not compatible with the W-CDMA family of standards.
CDMA2000 is the common name for IMT2000.
CDMA2000 1X is the first step in the QUALCOMM 3G evolution to CDMA2000, it improves packet data transmission capabilities (bandwidth of up to 144kbps) and speeds in the network, and also boosts voice capacity by nearly two times over today's CDMA capacities.
CDMA2000 1x EVDO (Evolution Data Only) is the second step in the QUALCOMM 3G evolution to CDMA2000 1X EVDO it offers data speeds of up to 2.4 Mbps.
CDMA2000 1x EVDV (Evolution Data Voice) is an alternative second step in the QUALCOMM 3G evolution to CDMA2000. It provides data and voice together on a single 1.25 MHz channel, with data rates of up to 4.8 Mbps.
CDMA2000 3X is the third and final step in the QUALCOMM 3G evolution to CDMA2000. It provides data at a peak data rate of 2Mbps.
cdmaOne (IS95) is a digital mobile phone standard based on the CDMA principles and used in Korea and Japan. cdmaOne uses frequency ranges around 800MHz and 1900MHz. For migration to third generation mobile telephony, cdmaOne networks can be upgraded to the CDMA2000 broadband standard.
CDPD (Cellular Digital Packet Data) is a digital cellular standard used in some phones with bandwidth limited to 19.2 kbps.
Cell is the basic geographical building block of a cellular communications system. Service coverage for a given geography is provided by interlocking cells within the network. Each cell consists of a radio base station with a transmitter and receiver. The size of each cell is determined by the terrain, power level and forecasted number of users within the cell.
Cell Switching is a protocol, which enables a caller to move coverage from one cell to another without losing the telephone connection. A cellular system is designed to switch an active cell to a new cell without a noticeable drop in the connection.
Cellphone is the American term for a mobile phone.
Cellular Digital Packet Data see CDPD.
Cellular Telecommunications Industry Association see CTIA.
Channel is an individual UMTS radio channel defined in the IMT 2000 standard as having a bandwidth of 5 MHz. This means that an individual UMTS radio channel, for example, ranges from 1900 to 1905 MHz. The number of radio channels a UMTS provider can provide to customers depends on the frequency spectrum granted in the UMTS license from the government. Each UMTS radio channel can transport more than one connection and thus more than one subscriber can use the same channel.
Chip Code also known as Spreading Code. See DSSS.
CIMD (Computer Interface to Message Distribution) is a proprietary protocol developed by Nokia for its Artuse SMSC. It is used to allow two SMSCs to exchange messages between themselves.
Circuit Switch is a method of establishing a dedicated communications path established between two devices through one or more intermediate switching nodes. Unlike packet switching, digital data are sent as a continuous stream of bits through a circuit, which is established between the two devices. Bandwidth is guaranteed, and delay is essentially limited to propagation time.
CHTML (Compact HTML) is a subset of the HTML markup language developed by Access for NTT DoCoMo that works on mobile phones with i-mode capabilities. CHTML also adds several additional features not found in standard HTML, notably the

access keys and phone number shortcuts for links.
CLDC (Connected Limited Device Configuration) is a framework for J2ME applications targeted at devices with very limited resources such as pagers and mobile phones.
CLI (Caller Line Identification) is a service that allows a customer to see the number of the caller before answering the call.
Compact HTML see CHTML.
Computer Interface to Message Distribution see CIMD.
Conference Calling is a service, which allows more than two people to be connected to the call at the same time.
Connected Limited Device Configuration see CLDC.
Core Network is the main part of the UMTS network, which provides call control and subscriber authentication. Core network includes a radio access network, terminals and applications.
Core Routers are the switching computers used on the main connection links (backbone) of a network to transfer huge data volumes over the network.
Coverage refers to the geographical reach of a mobile phone network or system.
CRM (Customer Relationship Management) refers to the approach towards customers in which the company initiating consistent and valuable communication to their customers and prospects, allowing the company to attract new customers while retiaing existing customers.
CRTC (Canadian Radio-television and Telecommunications Commission) is an independent government agency responsible for regulating Canada's broadcasting and telecommunications systems.
CSD (Circuit Switched Data) is the traditional technology used for the exchange of data. A circuit connection is made that is exclusively reserved for the individual's use via a modem. It is an inefficient use of bandwidth since the circuit is used whenever the circuit is open even when data is not being transferred
CTIA (Cellular Telecommunications Industry Association) is a lobbying and trade group representing the US cellular industry.
Customer Relationship Management see CRM.
Customized Application for Mobile
Networks Enhanced Logic see CAMEL Server.
CWTA (Canadian Wireless Telecommunications Association) is an industry association for advocacy on behalf of the wireless communications industry in Canada

D

DAMPS (Digital Advanced Mobile Phone System) (is also known as TDMA [Time Division Multiple Access]) is a digital mobile phone network that operates in the US, Latin America, parts of Russia and Asia-Pacific.
DECT (Digital Enhanced Cordless Telecommunications) is an ETSI standard for digital portable phones, commonly used for domestic or corporate use. DECT can also be used for wireless data transfers. DECT is similar to the GSM cellular system but the major difference between the systems is the cell radius — DECT cells have a radius of 25 to 100 meters, while GSM cells are 2 to 10 km and there is no provision for handoff.
Digital Advanced Mobile Phone System see DAMPS.
Digital Enhanced Cordless Telecommunications see DECT.
Digital Subscriber Line see DSL.
Digital Video Broadcasting see DVB.
Direct Sequence Spread Spectrum see DSSS.
Direct Sequence Wideband Code
Division Multiple Access see DSWCDMA.

DMB (Digital Multimedia Broadcast) is a mobile TV air interfaces Digital Audio Broadcasting radio standard
DoCoMo is the predominant mobile phone operator in Japan. The name is officially an abbreviation of the phrase *Do Communications Over the Mobile Network,* but also means "everywhere" in Japanese. DoCoMo was spun off from its parent company Nippon Telephone and Telegraph (NTT) in August 1991 to take over the mobile cellular operations of NTT.
DoJa i-appli is an extension of the CLDC implementation of Java2, but is not compatible with J2ME/MIDP. It was co-developed by DoCoMo and Sun Microsystems.
DoD model (Department of Defense Model) is a layered abstract description for communications and computer network protocol design. It was created in the 1970s by DARPA for use in developing the Internet's protocols, and the structure of the Internet is still closely reflected by the DoD model. The DoD model has four layers: Layer 4 Process Layer is where the "higher level" application protocols such as SMTP, FTP and HTTP operate. Layer 3 Host-to-Host (or Transport) is where flow control and connection protocols exist, such as TCP.
Downlink refers to the data transmitted from the network to the subscriber. The return channel, from the subscriber to the network is known as the uplink.
Dropped Call is a wireless call that is unintentionally disconnected due to a system problem, lack of channel availability or dead spot in coverage.
DSL (Digital Subscriber Line) is a family of technologies that provide a digital connection over the copper wires of the local telephone network. Its origin dates back to 1988, when an engineer at a Bell research lab devised a way to carry a digital signal over the unused frequency spectrum. Today it is a popular form of broadband to the home and is often terminated with wireless technology such as WiFi.
DSSS (Direct Sequence Spread Spectrum) is a technique used for transmissions method in which a "noise signal" (sometimes called a *spreading code* or a *chip code*) is multiplied with the data to be transmitted. The noise signal is a pseudorandom sequence of 1 and -1 values, at a frequency much higher than that of the original signal, thereby spreading the energy of the original signal into a much wider band. The resulting signal resembles white noise, like an audio recording of "static," except that this noise can be filtered out at the receiving end to recover the original data. DSSS is the basis of CDMA. If the "noise signal" is an orthogonal Walsh code, then multiple channels can be created with each orthogonal code.
DSWCDMA (Direct Sequence Wideband Code Division Multiple Access) A 3G radio interface for UMTS, also known as UTRA FDD or WCDMADS, and adopted as the IMTDS 3G standard.
DVB (Digital Video Broadcasting) is a standard for digital TV that covers all media (satellite, cable and terrestrial). It supports Internet services at speed up to 6 Mbps and can be used on mobile devices.
Dual Band mobile phones that are capable of operating on two different frequencies to improve coverage.
Dual Mode mobile phones that are capable of working on more than one air interface (for example, CDMA2000 and WCDMA).

E

EGPRS (Enhanced GPRS) is another, less common term for EDGE.
EDGE (Enhanced Data rates for GSM Evolution) is a 2.5G technology, which boosts the speed of GPRS devices without having to fully upgrade to UMTS it has speeds of up to 184kbps.
EMI/UCP (External Machine

Interface/Universal Computer Protocol) is a proprietary protocol developed by LogicaCMG to allow SMSCs to exchange SMS messages between them.
Enhanced Data rates for GSM Evolution see EDGE.
Enhanced GPRS see EGPRS.
EPOC is a new operating system for mobile multimedia terminals developed by Symbian and used by Nokia, Sony, Ericsson, and Siemens.
ETSI (European Telecommunications Standard Institute) is an independent, nonprofit organization, whose mission is to produce telecommunications standards for today and for the future. ETSI is officially responsible for standardization of Information and Communication Technologies (ICT) within Europe.
European Telecommunications Standard Institute see ETSI.
EVDO (Evolution Data Only) is the common name for the second step in the QUALCOMM 3G evolution to CDMA2000 1X EVDO it offers data speeds of up to 2.4 Mbps.
EVDV (Evolution Data Voice) is the common name for the alternative second step in the QUALCOMM 3G evolution to CDMA2000. It provides data and voice together on a single 1.25 MHz channel, with data rates of up to 4.8 Mbps.
Evolution Data Only see EVDO.
Evolution Data Voice see EVDV.
Extensible Hypertext Markup Language see XHTML.
Extensible Markup Language see XML.
External Machine Interface/Universal Computer Protocol see EMI/UCP.

F

FDD (Frequency Division Duplex) is the first variation of WCDMA to be tandardized.
FDM (Frequency Division Multiplexing) is a scheme in which numerous signals are combined for transmission on a single communications line or channel. Each signal is assigned a different frequency (sub-channel) within the main channel.
FDMA (Frequency Division Multiple Access) is a scheme in which the frequency band allocated for wireless cellular telephone communication is divided into 30 channels, each of which can carry either voice or data. FDMA is a basic technology used in the analog AMPS system. With FDMA, each channel is assigned to only one user at a time. DAMPS also uses FDMA but adds a TDMA scheme to get three virtual channels out of each FDMA channel, tripling the number of calls that can be handled on a channel.
File Transfer Protocol see FTP.
FOMA (Freedom of Mobile Multimedia Access) is the brand name used by Japan's DoCoMo's for 3G services, which is based on WCDMA.
Freedom of Mobile Multimedia Access see FOMA.
Frequency is the rate of signal oscillation in hertz, meaning the number of times the wave form repeats itself in a second. One Hertz (Hz) is one cycle per second.
Frequency Band is the portion of the electromagnetic spectrum within a specified upper and lower frequency limit that has been allocated for a specific purpose.
Frequency Division Duplex see FDD.
Frequency Division Multiple Access see FDMA.
Frequency Spectrum is the total frequencies allocated and available for communication. Regulatory agencies monitor the occupancy of the radio spectrum and allocate the frequencies to specific individual and group users, enabling a large number of services to operate without interference.
FTP (File Transfer Protocol) is a software standard for transferring computer files between machines with widely different operating systems. It belongs to the application layer of the Internet protocol suite.

G

Gateway GPRS administrative information for each subscriber registered in their home GSM or 3GSM network. It also contains the current location of the mobile user.

H

Home Location Register see HLR.
Hotspot is a WiFi access point or area, in particular for connecting to Internet.
HSCSD (High Speed Circuit Switched Data) is a permanent connection (circuit) used to exchange data. This is a special form of Circuit Switched Data (CSD), which boost speed up to 34Kbps.
HSDPA (High-Speed Downlink Packet Access) is a mobile telephony protocol sometimes referred to as 3.5G or 3G. HSDPA is a packet-based data service with data transmission up to 8-10 Mbps (and 20 Mbps for MIMO systems) designed to work with UMTS.
HLR (Home Location Register) is a network element that contains all the administrative information for each subscriber registered in their home GSM or 3GSM network. It also contains the current location of the mobile user.
Home Location Register see HLR.
Hotspot is a WiFi access point or area, in particular for connecting to Internet.
HSCSD (High Speed Circuit Switched Data) is a permanent connection (circuit) used to exchange data. This is a special form of Circuit Switched Data (CSD), which boost speed up to 34Kbps.
HTML (Hypertext Markup Language) is a collection of formatting commands that create hypertext documents or web pages, to be exact. A web browser interprets the HTML commands embedded in the page and uses them to format the page's text and graphic elements. HTML commands cover many types of text formatting (bold and italic text, lists, headline fonts in various sizes, and so on), and also have the ability to include graphics and other non-text elements.
HTTP (HyperText Transfer Protocol) is the primary protocol used to convey information on the World Wide Web. The original purpose was to provide a way to publish and receive HTML pages but today it is used for many other purposes.
HTTPS (HyperText Transfer Protocol Secure) is the secure version of HTTP, the communication protocol of the World Wide Web.
Hyperlink is a reference in a hypertext document to another document or other resource. It is similar to a citation in literature.
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Hyperlink is a reference in a hypertext document to another document or other resource. As such it would be similar to a citation in literature. However, combined with a data network and suitable access protocol, it can be used to interactively fetch the resource

referenced.

Hypertext Markup Language see HTML.
Hypertext Transfer Protocol see HTTP.

I

iDEN (Integrated Digital Enhanced Network) is a mobile communications technology, developed by Motorola, which provides its users the benefits of both a trunked radio and a cellular telephone. iDEN places more users in a given spectral space, compared to analog cellular systems, by using time division multiple access (TDMA). Six communication channels share a 25 kHz space; some competing technologies place only one channel in 12.5 kHz.
IETF (Internet Engineering Task Force) is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet.
IM (Instant Messaging) is when two or more users are transmitting text in a real-time, conversational mode. There are many IM standards existing including AIM (AOL Instant Messenger), Yahoo Instant Messenger, OMA Wireless Village, MSN Messenger, Jabber and ICQ.
IMEI (International Mobile Equipment Identity) is a unique identity code for each GSM mobile phone that is sold. An IMEI is marked as invalid if it has been reported as stolen or is not type approved (i.e. approved for use on a GSM network.
i-mode is the brand name for the data services licensed by Japanese mobile phone operator DoCoMo. It uses a set of tightly defined standards to reduce the issues of handset diversity.
IMT2000 (International Mobile Telecommunications 2000) is the ITU standards for 3G wireless communications, it consists of: IMT2000 CDMA Direct Spread also known as WCDMA or UTRAFDD as used in UMTS; IMT2000 CDMA Multi-Carrier is also known as CDMA2000, the successor to 2G CDMA (IS95); IMT2000 Time Code is also known as UTRATDD and TDSCDMA; IMT2000 TDMA Single Carrier also known as EDGE, an intermediate 2.75G technology; and IMT2000 FDMA/TDMA also known as DECT.
Industry Canada (IC) is the Government of Canada department responsible for competition, consumers, information highway, investment, regulation and science.
Instant Messaging see IM.
Internet Engineering Task Force see IETF.
Internet Protocol see IP.
Internet Protocol, Version 6 see IPv6.
Integrated Digital Enhanced Network see iDEN.
International Mobile Equipment Identity see IMEI.
International Mobile Telecommunications 2000 see IMT2000.
International Organization for Standardization see ISO.
International Telecommunications Union see ITU.
International Telecommunication Union Terminal Special Study Group IMT2000 see ITUT SSG IMT2000.
ISO (International Organization for Standardization) is a developer of international standards. ISO is a network of the national standards institutes of 148 countries, on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system.
IP (Internet Protocol) is a communication protocol using packet-switching technique to transmit data over the Internet.
IPv6 (Internet Protocol, Version 6) is the next version of the IP protocol developed

because the Internet was running out of addresses for all the connected devices. IPv6 increases the address space from 32 bits to 128 bits and as a result, a significantly higher number of devices can be added.
IS41 is the Internet-work connection protocol for connecting systems based on both analog and digital standards.
IS54 is the technical name for the first generation TDMA also called AMPS.
IS95 is the technical name for the first generation CDMA (cdmaOne).
IS136 is the technical name for the second generation TDMA also called "Digital AMPS" or "DAMPS."
ITU (International Telecommunications Union) is the United Nations organization responsible for coordinating global telecommunications standards setting, radio spectrum allocation and regulation.
ITUT SSG IMT2000 (International Telecommunication Union Terminal Special Study Group IMT2000) is the ITU body charged with the evolution of IMT2000 systems.

J

J2ME (Java 2 Micro Edition) is a specific implementation of the Java 2 language, which is designed for use on mobile phones and other small footprint devices.
Java is the programming language developed by Sun Microsystems, which runs on a virtual machine and is thus highly portable.
Java 2 is the second version of the Java programming language.
Java 2 Micro Edition see J2ME.

K

Kilobits per second see Kbps.
Kbps (Kilobits per second) is unit of data rate expressed in the thousands of bits per second.

L

Linux is a computer operating system and its kernel. It is among the most famous examples of free software and of Opensource development. The term Linux strictly refers to the Linux kernel, but is commonly used to describe entire Unix-like operating systems (also known as GNU/Linux) that are based on the Linux kernel. Linux is being used for some smart phones.
Location Based Applications mobile applications that assist the end users to find community services expressed in terms of their current location such as cash machines, banks, hotels, restaurants, pharmacies, banks, gas stations and many other consumer services.
Location Based Service is a service that tracks a cellular phone user's location within the mobile network and such that location based applications and emergency services work properly. These services are made possible by a wide range of technology; GPS + Cell based (location)Tracking, Measuring Signal Attenuation (between a subscriber's hardware and a base station), Server Aided GPS System, Assisted GPS Tracking made of DSP Software based device and TOA(Time Of Arrival)/TDOA(Time Difference Of Arrival) Tracking.

M

MAN (Metropolitan Area Network) is a regional computer or communication network spanning the area covered by an average to large city.
Markup Language is an encoding scheme where by the structure of a document is conveyed but formatting is not. Markup languages are used to read structured information for subsequent formatting and rendering by another program. The World Wide Web is written in a markup language called HTML.
Micro Cells because of the density of mobile phone subscribers in large cities and crowded high rise buildings, mobile phone operators need to convert their networks from a fewer number of large cells to a larger number of smaller cells. Cells with a diameter of 10 to 20 miles are called Macro Cells. Cells with a diameter from 1 to 10 miles are called Micro Cells. Cells with a range of a few hundred meters to a mile are called Pico Cells.
Microbrowser is a software program, which allows the user to browse the web that has been optimized to run in the low-memory and small-screen environment of a mobile phone.
MIDlet is a Java program for embedded devices, more specifically the J2ME virtual machine. Generally, these are games and applications that run on a cellphone.
MIDP (Mobile Information Device Profile) is a specification put out by Sun Microsystems for the use of Java on embedded devices such as cellphones and PDA's. MIDP is part of the J2ME framework.
MIME (Multipurpose Internet Mail Extensions) is an Internet standard for the format of multimedia email. Virtually all Internet email is transmitted via SMTP in MIME format. Internet email is so closely associated with the SMTP and MIME standards that it is sometimes called SMTP/MIME email.
MM1 is the protocol based upon HTTP post and used to send binary MMS content from the phone to and from an MMSC.
MM2 is the protocol used within the MMSC for the relay.
MM3 is the protocol used by an MMSC to communicate with legacy email systems such that an MMS can be addressed to an Internet email address.
MM4 is an SMTP based API used to communicate between MMSCs.
MM5 is the protocol used by the MMSC to communicate with the HLR or Home Location Register such that the intended addressee can be located.
MM6 is the protocol used by an MMSC to communicate with external databases.
MM7 is an XML and SOAP based API, which is transported over HTTP Post and is used to build client-server applications that communicate between the Value-Added Service Provider (VASP) application and MMS Relay/Server (MMSC). By using the MM7 interface, the content providers can send/receive multimedia messages between their application and MMS-enabled mobile phones. MM7 can used to build value-added services such as server-based photo albums or printing services for photos.
MM8 is the protocol used for the MMSC to communicate with the billing system.
MMS (Multimedia Messaging System) is the logical evolution of the Short Message Service SMS, a text-only messaging system for mobile networks. MMS enabled mobile phones enable subscribers to compose and send messages with one or more multimedia (e.g. photos, audio, and video) parts. Mobile phones with built-in or attached cameras or with built-in MP3 players are very likely to also have an MMS messaging client.
MMSC (Multimedia Messaging System
Centre or MMS Relay/Server) is a network element in the mobile telephone network, which stores and delivers MMS messages.
MMS Relay/Server see MMSC.
MO (Mobile-Originated) refers to an SMS or MMS message, which has been originated on a mobile phone by a subscriber versus a computer.
Mobile Information Device Profile see MIDP.
Mobile-Originated see MO.

Mobile Station Integrated Services Digital Network see MSISDN.
Mobile-Terminated see MT.
Mobile Virtual Network Operator see MVNO.
MSISDN (Mobile Station Integrated Services Digital Network) is a 15-digit Number, which refers to the unique MSISDN subscriber ID allocated to each subscriber.
MT (Mobile-Terminated) refers to an SMS or MMS message, which has been terminated on a mobile phone.
Multimedia Messaging System see MMS.
Multimedia Messaging System Centre see MMSC.
Multi-purpose Internet Mail Extensions see MIME.
MVNO (Mobile Virtual Network Operator) is a company that buys network capacity from a licensed network operator to offer its own branded mobile subscriptions and value-added services.

N

Narrowband is a classification of the information capacity or bandwidth of a communication channel. Narrowband is generally taken to mean a bandwidth of 64kbs or less.
National Telecommunications and Information Administration see NTIA**.**
NMT (Nordic Mobile Telephone System) was the first generation mobile telephone system used in Scandinavia.
Node B is the UMTS name for base station.
Nordic Mobile Telephone System see NMT.
NTIA (National Telecommunications and Information Administration) is the US federal government department charged with the management of spectrum.

O

ODM (Original Design Manufacturer) is the term for companies that design and manufacture a product such as a mobile phone that is then sold under other brand names.
OFDM (Orthogonal Frequency Division Multiplexing) is a method of digital modulation in which a signal is split into several narrowband channels at different frequencies. OFDM is similar to conventional frequency division multiplexing (FDM). directed to a specific subscriber.
OHG (Operators Harmonization Group)
OIS (Open Interface Specification) is a proprietary protocol developed by SMSC vendor SchlumbergerSema for the exchange of SMS messages between two SMSCs.
OMA (Open Mobile Alliance) is a standards organization, which was previously called the WAP Forum. The mission of the Open Mobile Alliance is to facilitate global user adoption of mobile data services. OMA maintains, among other things, the WAP specification for providing web like access to mobile phones.
Open Interface Specification see OIS.
Open Mobile Alliance see OMA.
Opera is a cross-platform Internet software suite consisting of a web browser, email/news client, address book, RSS news feed reader, IRC chat client, and download manager. It is actively developed by Opera Software of Oslo, Norway. Opera has gained a leading role in browsers for Smart phones and PDA's with its Small Screen Rendering technology.
Operators Harmonization Group see OHG.

Original Design Manufacturer see ODM.
Orthogonal Frequency Division Multiplexing see OFDM.
Orthogonal Variable Spread Factor Codes see Walsh Code.
OSI Model see OSI Reference Model.
OSI Reference Model is a layered abstract description for communications and computer network protocol design, developed as part of the Open Systems Interconnect initiative. It is also called the OSI seven layer model, which consists of the following layers: 1 Physical Layer; 2 Data Link Layer; 3 Network Layer; 4 Transport Layer; 5 Session Layer; 6 Presentation Layer; and 7 Application Layer.
OVSF (Orthogonal Variable Spread Factor) Codes see Walsh Code.

P

Packet Data Protocol Context see PDP Context.
Packet Switching is a method to establish a virtual circuit in a communication network by subdividing the communications into short packets, which are routed through the network between the two communicating parties.
Paging Channel(s) are a modulated CDMA channels using Walsh Codes 1 through 7 and they are used as the digital control channels.
Palm OS is an operating system made by PalmSource, Inc. for personal digital assistants (PDA's) and Smart phones and manufactured by various licensees.
PAN (Personal Area Network) is a network, which covers only a few meters surrounding a user's workspace and provides the ability to synchronize computers, transfers files and gain access to local peripherals like printers and a range of pocket hardware. Bluetooth is a common wireless PAN.
PAP (Push Access Protocol) is the protocol used for WAP push. A Push Initiator connects to a Push Proxy Gateway (PPG). It communicates over PAP via either the Internet or over the Push Over-The-Air (Push OTA) Protocol to the WAP client. PAP supports the following operations: Push Submission, Result Notification, Push Cancellation and Status Query.
PCS (Personal Communications Services) is a generic term for providing wireless, voice and data communications incorporating digital technology.
PDC (Personal Digital Cellular) is a 2G mobile phone standard developed and used exclusively in Japan. Like D-AMPS and GSM, PDC uses TDMA. PDC uses 25 kHz carrier, 3 time slots, pi/4-DQPSK modulation and low bit-rate 11.2 kb/s and 5.6 kb/s (half-rate) voice codecs. PDC is implemented the in 800 MHz (downlink 810-888 MHz, uplink 893-958 MHz), and 1.5 GHz (downlink 1477-1501 MHz, uplink 1429-1453 MHz) bands.
PDP (Packet Data Protocol) context is a data structure, which is created on both the SGSN and the GGSN of the GPRS core network and is used to contain the subscriber's session information when the subscriber has an active IP session over GPRS. When a GSM or UMTS mobile user wants to use GPRS, the handset must first attach and then activate a PDP context. The process will allocate a PDP context data structure in the SGSN that the subscriber is currently visiting and the GGSN serving the subscribers access point. The PDP context data structure will store the subscriber's IP address, the Subscriber's IMSI, the Subscriber's Tunnel ID (TEID) at the GGSN, the Subscriber's Tunnel ID (TEID) at the SGSN, and the Subscriber's tunnel ID (TEID) allocated by the GSN. Through the PDP context data structure, the GPRS core network knows how to route tunneled data between the mobile phone and the IP network (e.g. the Internet).
Personal Area Network see PAN.
Personal Communications Services see PCS.
Personal Digital Cellular see PDC.
Personal Information Manager see PIM.

Pico Cell very small cells with a diameter from a few hundred meters up to a mile and used to boost mobile network capacity within very large buildings.
Pilot Channel is the un-modulated (i.e. Walsh Code of zero with no data) signal sent by all CDMA base stations or Node B's. The pilot channel is used by all mobiles linked to the cell as a reference. The pilot channel also provides a unique identifier for the base station.
PIM (Personal Information Manager) is a software application, which stores personal information such as appointments and address book entries electronically. PIM applications now ship with most mobile phones and have the ability to synchronize the information on your PC PIM with your mobile phone PIM.
POC (Push-to-talk Over Cellular) is the technology in which a mobile phone acts like a digital walkie-talkie by providing a half duplex voice channel.
POTS (Plain Old Telephone Service) is the term that refers to the traditional voice telephone service provided by the PSTN.
PPG (Push Proxy Gateway) is a network Element that accepts client requests from the Push Initiator, which sends a HTTP post request formatted according to the PAP (Push Access Protocol). The PPG interprets the PAP and formats it and sends it to a WAP phone. The addressing, how to find the right phone, is incorporated in to the PAP specification. The big difference between the use of a PPG and the use of just ordinary WAP is that the PPG allows the communication to be initiated by someone other than the person holding the WAP phone in their hand.
PSD (Packet Switched Data) is any technology in which the communication channel for data is shared between several users. Typically, billing for PSD is done on the volume of data and not the duration of the connection and thus the connection is always present in the background.
PSTN (Public Switched Telecomm Network) is the public, fixed-line telephone network.
Public Switched Telecomm Network see PSTN.
Push Access Protocol see PAP.
Push Proxy Gateway see PPG.
Push-to-talk see POC.
Push-to-talk Over Cellular see POC.

Q

Quad Band is a GSM mobile phone, which supports the ability to transmit and receive on all four GSM frequencies used around the world. Quad Band phones are made to better support international roaming by supporting both American frequency bands (i.e. 800MHz and 1900MHz) as well as one of the European frequency bands (i.e. 900MHz and 1800MHz).
QUALCOMM is a wireless telecommunications research and development company based in San Diego, California. QUALCOMM developed a Digital cellular telephony technology based on CDMA; the first version was standardized as IS-95. It has since developed newer variations on the same theme, including IS-2000 and 1x-EVDO. It formerly manufactured both CDMA cell phones and CDMA base station equipment. QUALCOMM sold its base station business to Ericsson and its cellphone manufacturing to Kyocera, and now focuses on developing and licensing wireless technologies and selling ASICs that implement them.

R

Radio Interface is the system of signalling Protocols, which enable a mobile phone to

connect and thus communicate with the network.
Really Simple Syndication see RSS.
Real-time Transmission Protocol see RTP.
Roaming is the ability for a mobile phone to work outside its home area. Each mobile phone is registered to a home network. When the mobile phone is taken outside that home area, the two networks must have a roaming agreement set up to enable authentication and billing between the two networks.
RSS (Really Simple Syndication) is a group of XML based web content distribution and republication protocols primarily used by news sites and weblogs (blogs).
RTP (Real-time Transmission Protocol) is an IP protocol to provide end-to-end network transport functions suitable for applications transmitting real-time data, such as audio or video using multicast or unicast network services.

S

SAT (SIM Application Toolkit) is a set of Commands, which defines how the SIM card should interact with the outside world and extends the communication protocol between the card and the handset. With SIM Application Toolkit, developers can build handset independent programs, which can interact and perform transactions with the network. In 2G networks, SIM Application Toolkit (SAT) was defined in GSM 11.14 standard. GSM 11.14 has been updated to 3GPP 31.111, which also includes specifications of USIM Application Toolkit (USAT) for 3G networks.
Standard Generalized Markup Language see SGML.
Satellite Mobile Phones are mobile phones, which communicate via satellite rather than ground, based cells. They are used in locations where connection to ground based cells is not practical such as transoceanic flights, at sea, and in extreme rural areas.
Satellite UMTS see SUMTS.
SUMTS (Satellite UMTS) is a specification in which a satellite-based system provides some of the ground based UMTS system's capabilities.
SDMA (Space Division Multiple Access) is a scheme used to increase the capacity of a cellular mobile radio system by taking advantage of spatial separation between users. The base station does not transmit the signal to the entire cell area, as in conventional access techniques, but concentrates power in the direction of the mobile unit for which the signal is directed, reducing it in the directions where other units are present.
Secure Sockets Layer see SSL.
Service Provider is the company that owns the contract with the mobile phone subscriber and is responsible for billing.
Serving GPRS Support Node see SGSN.
Session Initiation Protocol see SIP.
SGML (Standard Generalized Markup Language) is the ISO standard for encoding documents in which the structure of the document is conveyed along with the contents. SGML was the basis for the HTML markup language used for the World Wide Web and subsequent ISO standard called XML.
SGSN (Serving GPRS Support Node) is the element in the GSM GPRS core network, which carries out the inter-working between the GGSN and the connected radio network. The SGSN connects the GGSN and the radio network in both GSM and UMTS.
Short Code is an abbreviated number on a mobile phone that when dialed will connect the user to a Value-Added Service. For example, when dialing 22222 on the mobile phone in Canada, the subscriber is connected to CBC Mobile on Demand. Short codes are used to provide access to a number of services including both voice and data.
Short Message Peer-to-Peer Protocol see SMPP.
Short Message Service see SMS.

Short Message Service Centre see SMSC.
Signaling System #7 see SS7.
SIM (Subscriber Identity Module) is a smart chip technology, which holds an application to authenticate the mobile phone subscriber on a network. Typically the SIM will also contain other data such as PIM data and programs built using SIM Tool Kit.
SIM Application Toolkit see SAT.
Simple Mail Transfer Protocol see SMTP.
SIP (Session Initiation Protocol) is an IETF proposed standard for setting up sessions between one or more clients. It is currently (2004) the leading signalling protocol for Voice over IP, gradually replacing H.323 in this role.
Smart Antenna is an electronically steerable antenna, which can direct radio signals to an intended target rather than broadcasting throughout the entire cell area to increase the network's capacity by achieving spatial separation.
Smart Phone is generally considered any handheld device that integrates PIM and mobile phone capabilities in the same device. Often, this includes adding phone functions to already capable PDAs or putting "smart" capabilities, such as PDA functions, into a mobile phone. Smart phones generally have operating systems that consist of Linux, Palm OS, Symbian EPOC, or Windows CE (also known as PocketPC or SmartPhone).
SMIL (Synchronized Multimedia Integration Language) pronounced "smile"; it enables simple authoring of interactive audiovisual presentations. SMIL is typically used for rich media applications, which integrate streaming audio and video with images, text or any other media type. SMIL is an easy-to-learn HTML-like language, and many SMIL presentations are written using a simple text editor. SMIL is used with MMS for mobile applications.
SMPP (Short Message Peer-to-peer Protocol) is the protocol used by SMSC to exchange SMS messages between themselves. SMPP is the most common non-proprietary protocol and the one in widest use.
SMS (Short Message Service) popularly known as text messages, this service provides the ability to send 160 character messages between mobile phones.
SMSC (Short Message Service Centre) is a network element in the mobile telephone network, which delivers SMS messages.
SMTP (Simple Mail Transfer Protocol) is
the de facto standard for email transmission across the Internet. SMTP is a relatively simple, text-based protocol, where one or more recipients of a message are specified using an Internet email address.
Space Division Multiple Access see SDMA.
Spectrum is the range of electromagnetic radio frequencies used in the transmission of sound, data and television.
Spreading Code also known as Chip Code. See DSSS.
Soft Handoff is the handoff method used in wideband systems including CDMA and WTDMA. Unlike hard handoff in which the mobile needs to retune when switching from one cell site to another, in soft handoff, the mobile is communicating with both cells simultaneously and handoff can be performed without first breaking the connection.
Software Defined Radio technology allows network operators to simultaneously support multiple communications standards (e.g. GSM, CDMA, WCDMA) on the one network infrastructure without begin bound by a particular standard. Software Radios can be programmed such that a mobile phone can use the same radio set to pick up, for example, GPS, Digital Radio or Digital TV signals.
SS7 (Signaling System #7) is a set of protocols defined by ITUT and used to set up telephone calls. It is usually abbreviated to SS7 although in some European countries, specifically the United Kingdom, it is sometimes called C7. SS7 is the control network used in mobile telephone networks and it is also used to transport SMS messages.
SSL (Secure Sockets Layer) is a cryptographic protocol to provide secure

communications on the Internet.
Streaming Media is digital audio or video transmissions using IP protocols. The sound and image data are sent as an IP data stream to the subscriber typically using a protocol called RTP.
Subscriber Identity Module see SIM.
Symbian a joint venture set up by Ericsson, Nokia and Psion to develop an industry standard operating system for smart phones called EPOC. It was based upon the Psion operating system.
Sync Channel is the modulated CDMA channel using Walsh Codes 32 and is used to transmit system timing information and allows the mobiles to synchronize themselves with the base stations on the network.
Synchronous is a scheme in which the transmission and reception of data is synchronized to a common clock such that the data can be transmitted in blocks rather than individual characters.
Synchronized Multimedia Integration Language see SMIL.

T

TACS/ETACS is a first-generation mobile telephone system used outside the Nordic countries and the US.
TCP (Transmission Control Protocol) is a connection-oriented, reliable delivery, byte stream transport layer protocol for data communication, currently documented in IETF RFC 793. TCP does the task of the transport layer in the simplified OSI model used by the Internet. In the Internet protocol suite, TCP falls in the intermediate layer between the Internet Protocol below it, and an application above it.
TCP/IP (Transmission Control Protocol/Internet Protocol) is a protocol capable of linking different computer platforms although it was originally developed for use on the Internet; it is now the most widely used data protocol.
TDD (Time Division Duplex) is a second variation of WCDMA designed to better fit into the indoor environments where there is a need for high traffic density.
TDM (Time Division Multiplexing) is a scheme in which numerous signals are combined for transmission on a single communications line or channel. Each participant is allocated time slots in which they are allowed to transmit their data, which has been broken up into small packets.
TDMA (Time Division Multiple Access) is the replacement name for the Digital AMPS (DAMPS) mobile standard is also called ANSI136. It is used primarily in the Americas and Asia Pacific and is delivered in the 800 MHz and 1900 MHz frequency bands.
TD-SCDMA (Time Division Synchronous CDMA) is special transmission method for UMTS co-developed by Siemens and the China Academy of Telecommunications Technology (CATT). TDSCDMA is to be used for setting up UMTS mobile phone networks in China. It combines the SCDMA technique developed by CATT with the TDCDMA method proposed by Siemens and other manufacturers. The S in 'SCDMA' refers to the special synchronous mode: All radio base stations transmit and receive synchronously: they prevent unavoidably occurring feedback interferences with asynchronous radio methods.

Terminal is an end user device on a network and can be a notebook computer, PC, TV, phone, mobile device, appliance etc.
Time Division Duplex see TDD.
Time Division Multiplexing see TDM.
Time Division Synchronous CDMA see TD-SCDMA.

TLS (Transport Layer Security) is the successor to SSL and a cryptographic protocol which provide secure communications on the Internet.
Traffic Channels are a modulated CDMA channels using Walsh Codes 8 through 31 and 33 through 63. The traffic channels are used to carry digitized voice data. A single base station can have up to 55 traffic channels.
Transport Layer Security see TLS.
Transmission Control Protocol see TCP.
Tri-band refers to a GSM phone that is able to operate on three of the four GSM bands around the world. A US tri-band phone will operate on both the American frequency bands (i.e. 800MHz and 1900MHz) as well as one of the European frequency bands (i.e. 900MHz and 1800MHz) while a European tri-band phone will operate on both European frequency bands and one of the American frequency bands. Tri-band phones are used to roam across the entire GSM world.

U

UDP (User Datagram Protocol) is a minimal message-oriented transport layer protocol that is currently documented in IETF RFC 768. In the TCP/IP model, UDP provides a very simple interface between a network layer below and an application layer above. UDP provides no guarantees for message delivery and a UDP sender retains no state on UDP messages once sent onto the network.
UICC (USIM Integrated Circuit Card) is smart card, which contains a chip used in mobile terminals in 3G telecom networks systems. The UICC is an essential component for UMTS, just as the SIM was for GSM. Extending the concept of the SIM card, the UICC contains the USIM application and also provides a platform for other IC Card applications. It ensures the integrity and security of all kinds of personal data, enabling secure support for all kinds of multi-application schemes.
UIM (UMTS Identity Module) is the SIM card equivalent planned for WCDMA handsets.
UMTS (Universal Mobile Telecommunication System) is the nearly universally subscribed standard for the third generation mobile, which is generally based on WCDMA (Wideband Code Division Multiple Access) technology. UMTS can provide permanent Internet connection of at least 384kbps and up to about 2mbps, combined with highly integrated devices and a super-fast back end.
UMTS Subscriber Identity Module (USIM) see UICC.
UMTS Terrestrial Radio Access see UTRA.
UMTS Terrestrial Radio Access Network see UTRAN.
Uniform Resource Locator see URL.
Universal Mobile Telecommunication System see UMTS.
Universal Wireless Communications 136 see UWC136.
Uplink is the term for data transmission in the direction from the subscriber to the network. The opposite transmission direction is called the downlink.
URL (Uniform Resource Locator) is the address or specification to locate an item on the Internet. It is an absolute reference. Each web page and each WAP page has a unique URL.
User Agent is the client application used with a particular network protocol; the phrase is most commonly used in reference to those that access the World Wide Web such as the browser on a PC or a mobile phone but it could also refer to an SMS, MMS, or email client.
User Datagram Protocol see UDP.
USIM see UICC.
USIM Integrated Circuit Card see UICC.
UTRA (UMTS Terrestrial Radio Access) is the term used for UMTS radio access

solution, applied to WCDMA and TDCDMA
UTRAN (UMTS Terrestrial Radio Access Network) is the term describing the Radio Network Controllers and Node Base stations of a UMTS network. The UMTS network is built around an IP-optimized core network carrying all traffic types including voice and video. UTRAN will support both UTRA Frequency Division Duplex (FDD) and Time Division Duplex (TDD) radio interfaces allowing flexible, high-bandwidth support, and will be connected to an IP-optimized core network through a UTRAN Gateway.
UWC136 (Universal Wireless Communications 136) is the TIA standard adopted by the ITU for 3G. UWC136 is a 3G TDMA standard that allows the US TDMA community to migrate from 1st (IS136) to 3rd (UWC136) generation systems. The standard uses a wideband TDMA technique.

V

Video On Demand see VOD.
Visitor Location Register see VLR.
VLR (Visitor Location Register) is a network element, which contains selected administrative information from the Home Location Register (HLR), necessary for call control and provision of the subscribed services for each mobile subscriber who is roaming in the geographical area controlled by the VLR.
VOD (Video On Demand) is a service that allows subscribers to watch video programming at the time when they want and usually with the ability to pause and restart the programming.
Voice over Internet Protocol see VoIP.
VoIP (Voice over Internet Protocol) is an IP-based technology used to transmit voice calls over the Internet using IP packets.

W

W3C (World Wide Web Consortium) created in October 1994 to lead the World Wide Web to its full potential by developing common protocols that promote its evolution and ensure its interoperability.
Walsh Code is used to uniquely define individual communication channels using DSSS. Walsh codes are orthogonal mathematical codes. As such, if two Walsh codes are correlated, the result is intelligible only if these two codes are the same. As a result, a Walsh-encoded signal appears as random noise to a CDMA capable mobile terminal, unless that terminal uses the same code as the one used to encode the incoming signal. Because of Walsh Codes, multiple CDMA users can share the same spectrum without interference.
WAN (Wide Area Network) is a large network spanning a country or around the world. The Internet is a WAN.
WAP (Wireless Application Protocol) is a protocol similar to the World Wide Web but optimized for mobile phones. The development of WAP is being driven by the Open Mobile Alliance (formerly known as the WAP Forum).
WAP Push (Wireless Access Protocol Push) is a specially encoded message, which includes a link to a WAP page or address. The WAP Push message can be delivered using either PAP or using an SMS bearer. On receiving a WAP Push message, a WAP 1.2 or later enabled handset will automatically give the user the option to access the WAP content. The big difference between ordinary WAP and WAP Push is that WAP Push allows the communication to be initiated by someone other than the person holding the WAP phone in his hand.

WCDMA (Wideband Code Division Multiple Access) is one of three 3G standards that makes use of a wider spectrum than CDMA and therefore can transmit and receive information faster and more efficiently. WCDMA is being backed by NTT DoCoMo and the European mobile industry and is expected to compete with CDMA2000 to become the de facto 3G standard.
Weblog (also known as a blog) is a web Application, which contains periodic posts on a common webpage. These posts are often but not necessarily in reverse chronological order. Such a website would typically be accessible to any Internet user. The term "blog" came into common use as a way of avoiding confusion with the term server log.
Wide Area Network see WAN.
Wideband is the classification of the information capacity or bandwidth of a communication channel. Wideband is generally taken to mean a bandwidth between 64kbits/s and 2Mbit/s.
Wideband Code Division Multiple Access see WCDMA.
Wideband iDen see WiDen.
Wideband Time Division Multiple Access see WTDMA.
WiDen (Wideband iDen) is a 2.5G evolution over iDEN used to provide high data rates for packet data, providing a mid next generation technology called WiDEN. WiDEN is an expansion on the current iDEN system, where instead of using a normal 25kHz channel for packet data, it will encompass 4 carriers (100kHz) into one channel. This will allow download speeds of 96kbps.
Windows CE (also known as WinCE) is a variation of Microsoft's Windows operating system for very small computers and embedded systems. Windows CE is a distinctly different kernel, rather than a trimmed down version of desktop Windows. Many platforms have been based on the core Windows CE operating system, including Microsoft's Handheld PC, Pocket PC, Pocket PC 2002, Pocket PC 2003, Pocket PC 2003 SE, Smartphone 2002 and Smartphone 2003.
WiFi (Wireless Fidelity) is the nickname and brand name given to 802.11 a wireless LAN technology.
WiMax (Worldwide Interoperability for Microwave Access) is the nickname given to IEEE 802.16, which is a wireless standard for point-to-multipoint broadband wireless access. WiMAX is a wireless metropolitan area network (MAN) technology that will connect IEEE 802.11(WiFi) hotspots to the Internet and provide a wireless extension to cable and DSL for last mile (last km) broadband access.
Wireless Access Point or AP is a device that connects wireless communication devices together to create a wireless network using WiFi or 802.11. The WAP is usually connected to a wired network, and can relay data between devices on each side.
Wireless Application Protocol see WAP.
Wireless Access Protocol Push see WAP Push.
Wireless Fidelity see WiFi.
Wireless Markup Language see WML.
Wireless Metropolitan Area Network see WMAN
WLAN Wireless Local Area Network
WMAN (Wireless Metropolitan Area Network) is a regional wireless computer or communication network spanning the area covered by an average to large city.
WML (Wireless Markup Language) is a markup language developed specifically for WAP and based on XML; it is similar to the HTML markup language used on the World Wide Web.
WTDMA (Wideband Time Division Multiple Access) is a scheme based on time division transmission, which is similar to that used by GSM but provides a much higher transmission rate. It was submitted as a solution for UMTS radio interface, but was rejected.
World Wide Web Consortium see W3C.

Worldwide Interoperability for Microwave Access see WiMAX.

X

XHTML (eXtensible HyperText Markup Language) is the markup language that reproduces, subsets, and extends HTML, but is reformulated in XML. XHTML -- documents are all XML-based, and ultimately are designed to work in conjunction with XML-based u browsers. XHTML is the successor of HTML

XHTML Basic is an XML-based structured markup language primarily used for simple browsers such as those typically found on mobile devices. XHTML Basic is a subset of XHTML and includes the minimal set of XHTML modules for document structure, images, forms, basic tables, and object support. XHTML Basic It will replace WML and CHTML as more compliant user agents are developed.

XHTML Mobile Profile is a Nokia project based on XHTML Basic, with the goal to add mobile phone specific elements to XHTML Basic.

XML (eXtensible Markup Language) is a subset of SGML with the goal to enable generic SGML to be served, received, and processed on the web as a replacement for HTML. XML has been designed for ease of implementation and for interoperability with both SGML and HTML.

Chapter 7

Companies Surveyed and Interviewed

As part of conducting the background research for some portions of this study, and for the purpose of collecting input from a variety of companies participating in the value chain, KAZAM conducted web surveys and phone interviews. Companies of Canadian and International origin were interviewed to provide both internal and external data points. Vendors, operators, wireless associations, government bodies and wireless clusters across Canada participated in the survey.

Company Name
American Wireless Technologies Inc.
BelAir Networks
Bell Enterprise Group, Bell Canada
bitHeads, inc.
Cascada Mobile
CGI Group Inc
CHUM Limited
Consilient Technologies
Contec Innovations Inc.
Communications Research Centre Canada
EION Inc.
Ericsson Canada
Gennux Microsystems Corp.

Company Name
GEOTrac International Inc.
IC Magic Inc.
Industry Canada
International Trade Canada
illumiCell Corporation
Institut International des Telecommunications
Jambo Mobile
Lighthorse Technologies Inc.
m-trilogix
MyThum
ooober Inc.
Ottawa Wireless Cluster
Redknee Inc.
Rossbro Technologies Inc
SaskTel International
Sendum Wireless Corporation
Sierra Wireless
TELUS
Titanium Mobile
Toronto Wireless User Group
VCom Inc.
VeriSign
Virgin Mobile Canada
Vodafone Group
Wireless Innovation Network British Columbia
WiTec

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