ANALYSIS OF THE NEW SITE DEVELOPMENT PROCESS FOR A WIRELESS TELECOMMUNICATIONS CARRIER

by

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ABSTRACT

This thesis examines the new site development process for a telecommunications carrier. Evolutions in cellular technologies have led to an exponential increase in the need for network resources. This has translated into rising development costs for the industry, mainly due to the increasing negotiating power of landlords and to stricter regulations by government bodies.

The existing new site development process was found to be missing return on investment (ROI) analysis and validation of the value provided by locations for new sites such as towers, rooftops and monopoles acquired by the real estate department. This paper proposes an updated process, to be adopted by the implementation team that would address these deficiencies and would guarantee that every installation carried out by the team would provide positive value for the organization.

DEDICATION

To my lovely parents, sister, grandparents and wife, who have supported and assisted me along my journey.

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GLOSSARY

3G	Third Generation network, set of standards that allow minimum mobile data rates of 2Mbps (384kbps for mobile users) and peaks of 21Mbps
4G	Fourth Generation network, set of standards that allow mobile data speeds up to 1 Gbps (100Mbps for mobile users)
AMPS	Advanced Mobile Phone System, first set of standards that allowed for a commercial implementation of a cellular network.
ARPU	Average Revenue per User, metric used by telecommunication providers to track revenue sources and value provided
BSC	Base Station Controller, section of a wireless network responsible to handle mobility functions and signalling between the phone and the switch
BTS	Radio Base Station, also referred as RBS, equipment that facilitates communication between the user device and the wireless network
CAPEX	Capital Expenditure, expenditures incurred either to buy fixed assets or to improve the value of a fixed asset
CDMA	Code Division Multiple Access, channel access method used by wireless telecommunication companies that allows several users to send information simultaneously over a single communication channel by using a special coding scheme
Churn	% of subscribers lost or gained by a telecommunications carrier, metric used by telecommunication providers to track growth
EBITDA	Earnings Before Interest Taxes Depreciation and Amortization, metric used by companies to track profitability
Erlang	Unit of measured load on a number of service elements (circuits for telephony applications) during a period of time
Erlangb	Probability of lack of service due to all available circuits being in use
GSM	Global System for Mobile communications, set of standards developed by the European Telecommunications Standard Institute to describe protocols for second generation networks
HLR	Home Location Register, central database that contains user information to be used by the network
IP	Internet Protocol, communications protocol used to access and transfer information across a network
LTE	Long Term Evolution, first commercial implementation of the 4G standard
MSC	Mobile Switch Center, element that controls and coordinate BSC elements on a network
OPEX	Operational Expenditure, expenditures incurred to run a business, product or system

PDA	Personal Digital Assistant, mobile device that functions as a personal organizer, currently obsolete with the emergence of smartphones
PMO	Project Management Office, department within an organization that maintains and develops standards for project management within the company
PP&E	Property Plant & Equipment, non-liquid assets that cannot be easily converted into cash
PSTN	Public Switched Telephone Network, term for the network containing all publicly connected networks
ROI	Return on Investment, metric used to evaluate the efficiency of an investment, calculated by dividing the profit of an investment by the cost of it
Sub-band A	A Band in the wireless frequency spectrum, ranging between 824-891 MHz
Sub-band B	A Band in the wireless frequency spectrum, ranging between 835-894 MHz
TDMA	Time Division Multiple Access channel access method used by wireless telecommunication companies that allows several users to send information simultaneously over a single communication channel by dividing access by time
UMTS	Universal Mobile Telecommunications System
Wi-Fi	Technology that allows an electronic device to exchange data through a radio environment using a computer network

1: INTRODUCTION

The business models of wireless telecommunication companies in Canada rely on providing users with a cellular device with voice and data services. With access to the same technology and devices, these companies have focused their product differentiation on quality of service in recent years. The Rogers Wireless advertisement campaign of 2011 claimed that Rogers was "Canada's Fastest Network".[1] TELUS claims to have "Canada's fastest coast-to-coast 4G network";[2] and Bell launched a campaign in 2012 stating that they had the "Largest, fastest, and most reliable network".[3] These claims have led to several legal disputes and operators have had to provide key performance indicators (KPI) in order to back up their claims.

KPI indicators include dropped calls, data speeds and the level of connectivity or accessibility to the network, which depends on the number of network resources that a carrier has deployed. To achieve the goal of being the best serving network in Canada, competing companies have significantly increased their network assets in order not only to provide a positive customer experience but also to perform better than the competition. To achieve this goal companies seek to install more sites in better locations than their competitors do. This has led to a race to build new sites all across Canada.

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[1] http://www.newswire.ca/en/story/893679/canada-s-largest-and-fastest-lte-network-the-rogers-lte-network-is-now-live-in-more-cities-surrounding-toronto-and-vancouver

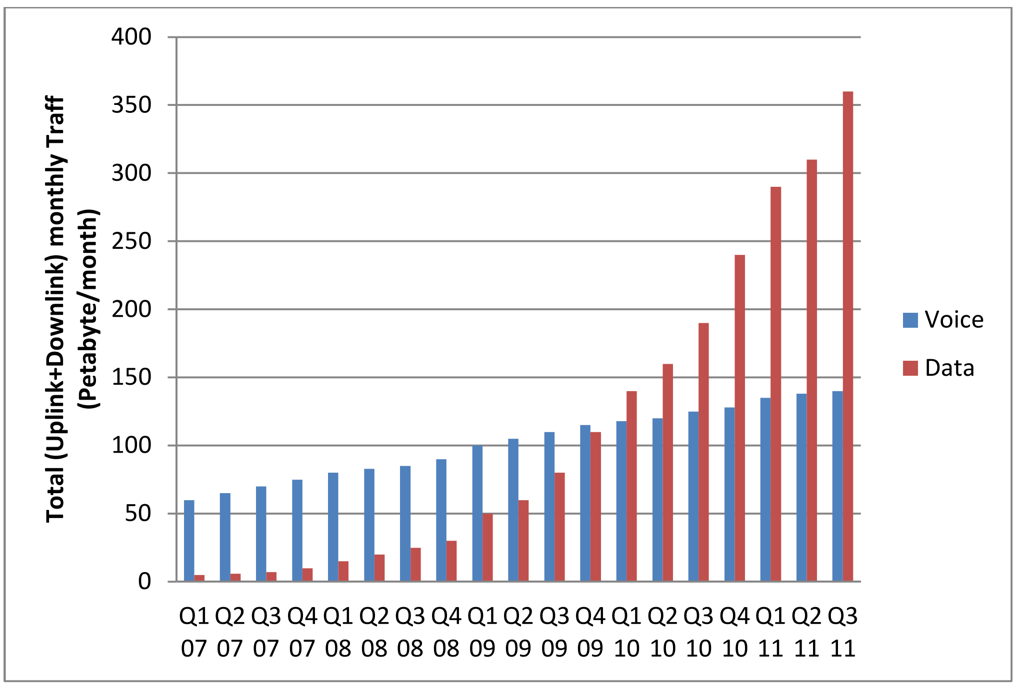
[2] 2011 TELUS Communications Inc. Annual Report

[3] http://www.iphoneincanada.ca/iphone-news/rogers-sues-bell-over-false-advertising/

A cellular site is a location where antennas, transmission equipment, processors and radio transmitters are placed to create a coverage area in a mobile network (Pashtan, 2005). This location could be a radio mast, a silo, a tower, a building's rooftop, or any high structure that can host the required equipment for the purposes of serving the needs of telecommunications providers and their customers.

Growing demand for wireless services has led to an exponential rise in the number of wireless cellular sites. The number of smartphone users in Canada has increased by 48% over the last year (Quorus Consulting, 2012), and this amount is expected to grow further over the next three years; it is also estimated that Wi-Fi and cellular data will account for 60% of all internet traffic by 2016 (Cisco, 2012). Figure 1 shows that mobile voice traffic has doubled worldwide over the last four years, and that mobile data traffic has doubled in one year, between 2010 and 2011.

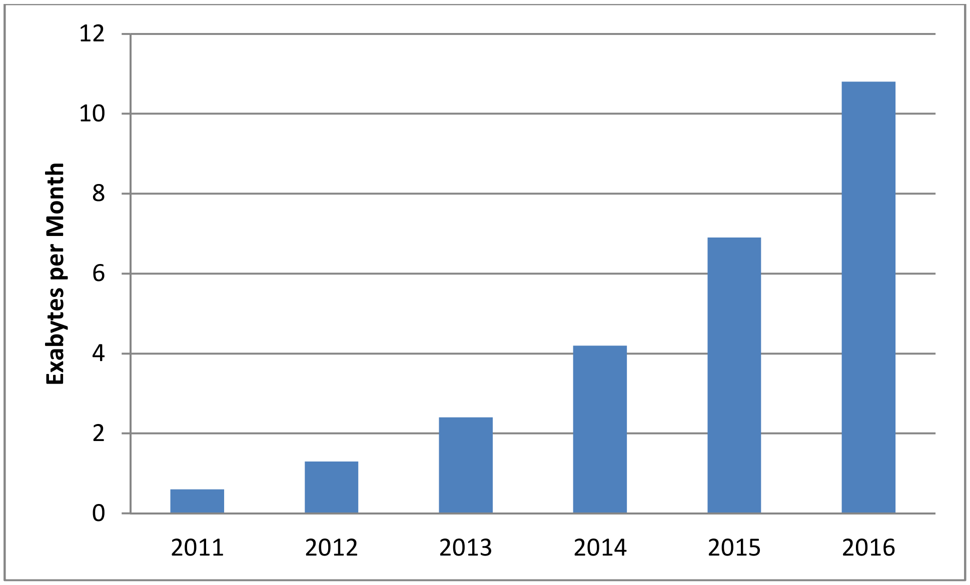
Figure 1: Global Total Traffic in Mobile Networks



Source: Adapted from the Ericsson Traffic and data market report, February 2012

This exponential increase in mobile data traffic is expected to continue in the future. The 2012 Cisco Visual Network Index (VNI), an annual report that monitors the development of mobile broadband across the world, projects a compounded annual growth rate of 78% from 2011 to 2016 (Cisco, 2012), as shown in Figure 2.

Figure 2: Worldwide Mobile Data Traffic Forecast



Source: Adapted from the the Cisco VNI Report, May 2012

In terms of keeping up with this demand, cellular telecommunications companies have limited ways of adding new capacity to their networks. When the capacity of their network is saturated, they have to add additional radios to transmit and receive information from their subscribers. This translates into a need for new antenna installations on their towers. Figure 3 represents a typical antenna installation on a telecommunications tower. Once a tower is overloaded with antennas, a new cellular site hosting new antennas at a different location is required to keep up with demand.

Figure 3: A Lattice Tower in North Vancouver, BC

Source: SFU Hazard Vulnerability Model, from http://www.sfu.ca/geog452spring00/project5/gallery.html

1.1 The Key Issue

The challenges of improving service provision discussed above have led to an increased demand for tower and rooftop sites by the telecommunications companies. According to Industry Canada, there are currently 13,758 cellular sites across the country and hundreds of new sites are being installed each year. For a number of reasons many Canadian cities have become very concerned about these installations and have put heavy restrictions, such as shrouding, building permits or tower height restrictions, on all new wireless installations. For example, citizens in the BC towns of Colwood and Metchosin have campaigned actively against new sites to the point of forcing Industry Canada to review the tower proposals;[4] the Vancouver School board has banned cell towers on school properties; and the Federation of International Labour Unions (AFL-CIO) has opposed cell installations on fire halls.[5]

Telecommunications companies face a difficult challenge in terms of finding the best way to improve the quality of their networks, as it becomes more and more difficult to acquire sites within different municipalities. The question becomes one of improving quality of service in the face of public resistance to new cellular installations.

Moreover, numerous community organizations such as Citizens for Safe Technology, Canadians for Responsible Placement of Cell Towers, or the Canadian Initiative to Stop Wireless, Electric and Electromagnetic Pollution, have come into being to campaign against cell tower installations. This continuous growth of opposition to cell towers is making it more difficult for telecommunications companies to provide coverage solutions to their customers, and is forcing them to accept locations that might not make sense financially.

As a result, telecommunications companies have been experiencing diminishing returns on network investments on new sites for two main reasons. First, new cellular sites have to be lower in height in order to gain planning approval from municipalities to minimize visual impacts. Lower cellular sites translate to a smaller footprint of cellular

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[4] Triangle Mountain Antenna Towers Review, http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08010.html
[5] http://www.antennamgt.com/antenna-resources/safety-code-6

coverage and a reduced number of subscribers benefiting from the new installation. Second, there has been an increase in the costs associated with new sites due to a number of new policies put into place by local authorities struggling to meet public approval for these contested installations. Examples of these policies include shrouding antennas to hide them in rooftops, painting installations to match their backgrounds and the use of "monopine" installations (monopole cell towers with branches attached to make them look like a pine tree). The following table shows that there has been an increase in the cost of average installations during the last four years and that cellular sites constructed before 2009 have a higher number of subscribers served per hour.

Table 1: Recent New Site Build Programs

Build Year Program	Simultaneous Users per Cell by July 2012 (Voice)	Simultaneous Users per Cell by July 2012 (data)	Average cost per Cell
Before	23.2674	17.3042	$ 375,320[6]
2009	23.4266	18.9572	$ 388,139
2010	19.3413	16.7909	$ 349,767
2011	16.2664	15.5753	$ 462,692
2012	17.7190	13.2083	$ 436,055

Source: Created by the author based on information from Canada Industry Statistics (CIS), 2012

The decrease in the number of simultaneously connected users per site for installations erected in the last three years, combined with the increase in installation costs translate directly to a decrease in return on investment (ROI) for the company. This trend has caused serious concerns in the industry.

[6] Average of the last 3 build years

This paper examines the current new site development process of one of the largest telecommunications carriers in Canada. This company will be analysed for the development of the proposed solution method, but for confidentiality reasons the name and details of the company must remain anonymous. The company is looking to revamp this process to include costs and ROI analyses in order to prioritize new installations, based not only on technical needs but also on the financial benefits of new sites.

The paper proposes a new methodology to help identify good location opportunities for the company, by creating a financial model that determines whether a site would provide a positive ROI.

1.2 Objective

The objective of this project is to assess the effectivity of the new site process in the organization. As the site development process is unique to each company, and tied to specific roles and responsibilities of their departments, there is not an industry standard that can be used as a benchmark to do this assessment. However, three major activities were done to support this objective.

First, a set of interviews was done with the major stakeholders, namely the network planning manager (responsible for determining network requirements), the implementation project manager (responsible for implementing the requirements), the RF optimization manager (responsible for approving implementations), the real estate manager, and two real estate analysts (responsible for acquiring site agreements). Each interview was done on a one-on-one basis and lasted an average of two hours per person. The interviews were done in order to get an understanding of the process, the flow of information, timelines, bottlenecks, and to determine if there was any limitation of the current new site development process. Next, a market analysis was done in order to understand the company and market strategies, competitive advantages, resources and customer needs with the intention to assess the alignment of these factors with the current new site development process. Lastly, a recommendation was developed and reviewed with the principal stakeholders in order to get validation of the benefits of the proposed solution, and to get buy-in to implement it in the future.

1.3 Organization of the Thesis

This paper starts with an overview of the industry in Section 2, describing the evolution of cellular networks in Canada and provides a summary of the status of the mobile market, describing major players in the market, their market penetration and concludes with forecasts for this market. Section 3 provides a discussion of the telecommunications industry in Canada in terms of Michael Porter's five forces framework, describing market competitors, substitutes, buyers, suppliers and barriers to entry.

Section 4 provides a background of the company, describing its mission, values and competitive advantages. Section 5 analyses the new site development process in the company and describes why this process is so important in the context of the competitive landscape of the industry. Using a data flow map, the key elements of the current process are mapped and its advantages and limitations are discussed. Section 6 provides an analysis of the process and proposes a solution to address the issue of increasing costs in the new site development process. Finally, Section 7 reviews conclusions and recommendations.

2: AN OVERVIEW OF THE WIRELESS TELECOMMUNICATIONS INDUSTRY IN CANADA

This section starts with a description of the evolution of cellular network technologies, followed by a history of the wireless telecommunications industry in Canada and an analysis of the major players in that market. The chapter closes with a discussion of the current status of the wireless market in Canada.

2.1 Cellular Networks Basics

2.1.1 Network Evolution

Wireless communications have evolved from the original analog Advanced Mobile Phone System (AMPS), introduced in 1978 (Young, 1978), to today's Long Term Evolution (LTE) phones. On the way, many different technologies have been developed, including TDMA, CDMA, GSM and UMTS.

Introduced by AT&T, the notion behind AMPS evolved from basic peer-to-peer radio communications, where one radio transmitted at a certain speed and frequency. AMPS used different radio frequencies to distinguish different users on a network, but unlike old systems, the cell centers allowed the same frequency to be reused by a different user in a different area as long as there was no interference.

As the number of users grew, cellular networks had to find efficiencies to incorporate additional numbers of users in a cell; this was achieved by a technology that split the number of users in a time slot, namely Time Division Multiple Access (TDMA).

This allowed users to transmit in rapid succession, one after the other, each within their own time slot, typically about twenty milliseconds (Pandey, 2009).

In the meantime, another technology was being proposed that allowed multiple users to connect to the system at the same time, using a different approach called Code Division Multiple Access (CDMA). Instead of transmitting sequentially, users transmitted through a modulated code, which was de-modulated later by the system (Kisiel, 2008). An analogy for this is having several people in a room talking at the same time but instead of taking turns to speak (TDMA), they use different languages to communicate(CDMA) (Brunner, 2000) . Both technologies have their advantages, but CDMA is able to carry more users. However, because CDMA is more sensitive to noise (Abtahi, Valaee & Tabiani, 2010), it requires better radio conditions and therefore more antenna installations for optimum performance.

Bell and TELUS both chose CDMA technology as their operating system in the lates 1990s, while Rogers selected TDMA with their sights set on a new technology that was developing in Europe, the Global System for Mobile Communication (GSM). This technology was based on TDMA, but with additional features such as data speeds of up to 50kbps, and phone locking with Subscriber Identity Module (SIM) cards. Cloning had been an issue that cost the telecommunications industry millions of dollars in the nineties and this technology added advanced features to combat the problem. As GSM became the dominant technology in the market, Rogers gained a market lead by offering consumers handsets that the other carriers could not offer, and by earning revenues by roaming, mainly through roaming agreements with other GSM wireless providers in over 138 countries throughout Europe, Asia, Latin America, and Africa. This segment accounted for 56.9% of Rogers' total revenue in 2011.[7]

In the early 2000's, applications began to require faster data rates, leading to the adoption of 3rd Generation (3G) Networks. These networks support data rates of up to 2Mpbs (384k for mobile users) and are based on CDMA technology (Korhonen, 2004). LTE is the latest technology on the market. It was developed as the long-term evolution of the 3G networks by the 3rd Generation Partnership Project (3GPP), with the intention of providing more capacity to meet the increasing needs of broadband. LTE introduced new features such as data speeds of over 300Mbps (Liu & Ying, 2009). Operators are deploying this technology in the 2.1MHz and 2.6MHz bands;[8] however, these are higher frequency bands that have lower in-building penetration (Lofberg, 2011) that require more sites to match previous technologies. Cell radius at 700MHz or 850 MHz (Used for GSM and 3G coverage) could be between three and four times larger than at 2.6 GHz. Therefore, from a coverage point of view, a network built at 700MHz or 850 MHz is likely to require less than a tenth of the number of sites required for the same coverage at 2.6 GHz (Capgemini, 2009).The Greater Vancouver Area (GVA) has 1246 cell tower installations used by the major players,[9] at as 2012, and will need several thousands of new LTE installations in order to match existing GSM or 3G coverage.

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[7] Zacks Investment Research. Rogers Wireless. July 2012, from http://www.zacks.com/stock/research/RCI/company-reports

[8] Study of Future Demand for Radio Spectrum in Canada 2011-2015. Industry Canada, from http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10275.html

[9] TAFL Industry Canada Database, from http://www.ic.gc.ca/eic/site/tafl-ltaf.nsf/eng/home

2.1.2 Network Topology

In a cellular network, coverage is divided into a number of areas that provide service in a geographic region. A base station (BTS) controls each geographic area, called a “cell”. The coverage of each cell will depend on different factors, such as transmission power, terrain features, user equipment and heights of the antennas. The higher the transmission antennas are, the higher the coverage (JDSU, 2010).

A base station is composed of multiple equipment that interacts with the user’s phone such as transmission radios and transmitter antennas that send information to the phone, transport equipment that sends the information back to the network and a base station processor that handles users’ sessions.

A group of BTS are connected to a Base Station Controller (BSC), which manages connections between the BTS as users move between cells. The BSC also allows the BTS units to communicate with each other. This happens when calls are placed between users. These calls are “assigned” by the Mobile Switch Centre (MSC), which is in charge of coordinating all telephony functions such as call switching and mobility management. The MSC uses subscriber data, such as phone numbers, areas of roaming, data, and voice allowances, which it obtains from the Home Location Register (HLR), and routes the calls to the Public Switched Telephone Network (PSTN) where other networks are located.

2.1.3 Capacity Planning

The BTS equipment has a limited number of simultaneous users that it can handle. This number varies depending on the technology. GSM has a limit of six radios per BTS cabinet (Ericsson, 1999) (12 if using a double radio unit), and each radio is able to support eight simultaneous users (Ericsson, 2002) for a total of 96 users per cell. CDMA in theory has no limit on the number of users, but its connections are limited by degradation of the signal and by noise when the number of simultaneous users exceeds a certain threshold (Sachs, Balon & Meyer, 1999).

The total number of users connected per cell (i.e. the volume of traffic) is constantly monitored by operators in order to avoid congestion and to achieve expected service levels. There are various methods that the operators use to collect this data, such as using the peak hour of the day, the fifth peak hour of the month (5^{th} peak), the average of the five highest hours of the month (5HDBH), or the ten busiest hours (10HDBH). Each method represents a figure of users per cell and different operators use the one most appropriate to the strategy they use to resolve congestion.

Capacity is determined by the grade of service (GOS) the carrier is willing to accept as congestion. Grade of service is defined as the quality of service that a circuit is designed or conditioned to provide.[10] Most wireless telephony systems are designed for a GOS of 2% (Rappaport, 1996), while wireline systems are designed to achieve a GOS of 1% (Lindberg & Sagerholm, 1988). A mathematical formula (erlangB distribution) is applied to the traffic to determine if it is expected to be congestion over 2% of the time (for wireless networks). In this case, it is considered that the total numbers of users in a geographical area covered by a specific cell is projected to exceed the capacity figure, and a capacity addition is required. If the BTS has enough capacity to host additional radios, they will be increased to meet the required GOS by applying an inverse erlangB formula. This will lead to antenna additions if the antennas have reached their port

[10] Telecommunications Industry Association(TIA). Glossary of Telecommunication Terms

capacity. If the cell reaches the limit of the number of radios or antennas that it can support a new cell location will have to be acquired to keep up with demand.

2.1.4 Coverage Planning

New cells are not only needed to cope with capacity constraints, they are also required to expand coverage in areas of no service. Poor service areas are determined either subjectively, based on customer feedback, or objectively, based on coverage maps that provide signal strength in a geographic area. There are two different types of maps: test drive data maps, and coverage plots.

Test drive data maps are generated based on measurements taken by an analyst in the field. Such analysts use test equipment that includes a GPS, a laptop that records the information, and different phones that are attached to the laptop. As the analyst drives through the geographic area, the test equipment attempts calls every second and records information of the location and the signal strength at that particular coordinate. These plots are very accurate but very expensive to produce at a high level of granularity, as they require more man-hours.

Coverage plots are simulations created by computer applications such as Mentum Planet, or Forsk Atoll, that calculate an estimated coverage footprint based on terrain features such as elevation or terrain blockage. These plots are faster to deploy (a simulation for a market takes minutes to process), but they are not 100% accurate, as the model does not take into consideration such criteria as buildings and direct lines of sight. Planning analysts have to balance the information acquired by both types of maps, to determine requirements. Figure 8 illustrates the presence of wireless cell providers in

Canada, modelled by a prediction tool. Different aspects such as engineering analysis to determine underserved areas, population studies, as well as marketing, sales and senior management inputs all play a factor in determining which locations would require an additional BTS in order to grow the network.

2.2 Wireless Telecommunications Industry in Canada

2.2.1 Government Regulation

Telecommunications industry regulation dates back to 1979, when the Canadian Radio-Television and Telecommunications Commission (CRTC) was created with the mandate to end the private monopoly on private lines connected with the Public Switched Telephony Network.[11]

CRTC's objective is to regulate the competitive environment in Canada and to ensure that Canadians receive reliable telephone and other telecommunications services, at affordable prices.[12] To do so, the CRTC is in charge of issuing and revoking telecommunications licenses, which in the case of wireless communications are determined by spectrum.

Wireless telecommunications companies operate on a radio frequency (RF) spectrum that is managed by the CRTC. The RF spectrum ranges from 9 kHz to 275GHz and is used by several applications; [13] from cellular phones, to TV broadcasting, to air

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[11] Industry Canada. Telecommunications Service in Canada: An Industry Overview, from http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf06283.html

[12] CRTC web site From http://www.crtc.gc.ca/eng/backgrnd/brochures/b29903.htm

[13] Industry Canada. Canadian Table of Frequency Allocations, from http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf01678.html

traffic control, to satellite communications. Industry Canada grants spectrum use to different entities by auctioning subsets of the RF spectrum, known as a frequency bands.

In 1983, the first wireless spectrum license was granted by the Department of Commerce (later known as the Department of Industry) to CANTEL who then became the first recipient of a cellular spectrum Sub-band A. At the same time, it was also announced that a second frequency band (Sub-Band B) would be made available for other carriers to apply for licenses, and that this band would be authorized to begin offering cellular service on July 1, 1985.[14]

In December 1995, a new spectrum allocation was issued, with the Department of Industry granting a 1900MHz frequency allocation to three national carriers: Clearnet PCS, Microcell Networks and Rogers Cantel.[15] The 1900MHz band allowed new entrants such as Microcell to compete with the incumbents and allowed existing carriers to provide more capacity to their networks.

The RF spectrum auction of 2008 raised a record setting amount of $4.254 billion in terms of winning bids.[16] Rogers, Bell and TELUS acquired national licences to deploy their LTE network, and new major players acquired licenses to compete in the wireless market including three cable companies: Shaw Communications in Western Canada, Quebecor's Videotron in Quebec and Bragg Communications' Eastlink in the Maritimes. At the same time two new companies entered the telecommunications market in Canada, namely Globalive Wireless (Wind Mobile), and DAVE Wireless (Mobilicity).

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[14] Industry Canada. A Brief History of Cellular and PCS Licensing. May 2010, from https://strategis.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08408.html

[15] Industry Canada. A Brief History of Cellular and PCS Licensing. May 2010, from https://strategis.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08408.html

[16] Auction of Spectrum Licences for Advanced Wireless Services and Other Spectrum in the 2 GHz Range: Licence Winners, from http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09002.html

In August 2012, the Department of Industry issued a public consultation notice that the auction of the 700MHz frequency band is expected to be launched in late 2013. This band was previously reserved for television channels, before the CRTC ended over-the-air TV broadcasting in August 2011.[17] The 700MHz band is attractive to carriers due to the lower costs associated with its deployment as service provision over lower frequencies can reach subscribers at a greater distance.[18] That will mean that the carriers that are successful in acquiring a piece of this frequency band will need fewer transmission sites to provide services to their customers.

2.2.2 Evolution of the Wireless Technologies in Canada

Cellular phones were first introduced in Canada in July 1985 by Cantel and Bell Cellular.[19] In those days the wireless market was an unproven industry with an unknowable future,[20] while mobile phones had a retail price of $3,700 and had to be carried in a shoulder bag.[21] The industry struggled in those early days. Bell had only 600 subscribers by the end of 1986,[22] but evolutions in electronics and technology equipment

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[17] CRTC. Broadcasting Public Notice. May 2007, from http://www.crtc.gc.ca/eng/archive/2007/pb2007-53.htm

[18] Industry Canada, Consultation on a Policy and Technical Framework for the 700 MHz Band and Aspects Related to Commercial Mobile Spectrum, August 2012. From http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09949.html

[19] Industry Canada. Canadian Municipalities and the Regulation of Radio Antennae and their Support Structures from http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09389.html

[20] Canada goes Cellular, from http://www.cbc.ca/player/Digital+Archives/Science+and+Technology/Applied+Science/ID/1767289567/?sort=MostPopular

[21] The Globe and Mail. A phone so big that came with its own baggage. Jul 2010, from http://www.theglobeandmail.com/report-on-business/a-phone-so-big-it-came-with-its-own-luggage/article1389639/

[22] The Globe and Mail. A phone so big that came with its own baggage. Jul 2010, from http://www.theglobeandmail.com/report-on-business/a-phone-so-big-it-came-with-its-own-luggage/article1389639/

have since made the technology accessible to the public and have transformed the industry into a multi-billion dollar market.

In 2002, Bell Canada launched CDMA technology to provide new network improvements over the analog network including improved voice call quality, better coverage, fewer dropped calls, improved security and greater capacity.[23] In response, in June 2003 Rogers completed their second generation network (GSM) deployment across a national footprint. This move gave Rogers a competitive advantage, as the GSM family of standards was successfully adopted by a large number of countries, particularly within Europe, becoming the leading digital wireless standard worldwide.[24]

In the final quarter of 2006, Rogers launched their Universal Mobile Telecommunications System (UMTS) network.[25] This technology was deployed to take advantage of increasing needs for throughput. The new network gave Rogers a further market advantage over their competitors by providing higher data rates and access to more advanced devices such as Apple’s iPhone. Bell and TELUS launched a joint 3G network in 2009 in response to Rogers’ UMTS network. [26] The adoption of this new technology by Bell and TELUS brought them into a more competitive landscape, for a number of different reasons.

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[23] CDMA Technology from http://www.satphonezone.com/cdmatechnology.html

[24] Andersen Consulting. The GSM-CDMA Economic Study. 1998. from http://sss-mag.com/pdf/fivexsum.pdf

[25] QSI Consulting. The State of Wireless technologies in Canada, 2007 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/dgtp-002-07-bell-Appendix-4.pdf/$FILE/dgtp-002-07-bell-Appendix-4.pdf

[26] http://www.marketnews.ca/content/index/page?pid=6106

- The combined deployment of the 3G network brought strategic savings in both operational and capital expenditures for both companies (Arthur D. Little Consulting, 2010)
- Customers were allowed to take their phones with them as they switched providers
- Companies had access to a greater variety of handsets, at a potentially lower cost, because devices were manufactured in greater volumes
- The roaming advantage that Rogers once had, with access to more than 80% of the roaming population,[27] was compromised by the adoption of 3G technologies by other carriers.

In 2009, Wind and Mobilicity launched their corresponding national UMTS networks and started operations in Canada. The launch of two new national operators improved the competitive landscape in the country and provided new options for consumers.

LTE was launched as a nationwide deployment in 2011 by Bell,[28] Rogers[29] and TELUS.[30] New entrants Wind[31] and Mobilicity[32] launched their 4G network deployments in 2012. With all carriers having access to the same technologies and devices,

[27] http://www.cbc.ca/news/technology/story/2008/07/21/tech-cellphones.html
[28] http://network.bell.ca/en/lte/?what
[29] http://redboard.rogers.com/2011/rogers-confirms-lte-deployment-invests-in-canadas-digital-fast-lane/
[30] http://about.telus.com/community/english/news_centre/news_releases/blog/2011/04/06/telus-to-deploy-4g-wireless-lte
[31] http://www.newswire.ca/fr/story/796063/wind-mobile-announces-successful-4g-live-trial
[32] http://mobilicity.ca/newsroom/mobilicity-moving-4g/

competition for network quality has to be focused on having the best people and processes in place.

2.2.3 Major Players

2.2.3.1 TELUS Communications Inc.

TELUS Corporation was created in 1990, following the reorganization of the Alberta Government Telephones Commission. The sale of TELUS shares marked the largest initial public offering in Canadian history up to this time, raising $896 million.[33] It was later merged with BCTEL (1998) and Clearnet (2000) to create one of the three largest telecommunications companies in Canada.

Over the course of time, TELUS introduced several innovations to the wireless industry such as: first in Canada to offer real time streaming satellite radio, first in Canada to offer a 1.3 MP camera phone, first in Canada to provide the world's slimmest QWERTY device and smallest "Mike" phone, and first in Canada to offer a Windows® based PDA camera phone.[34]

TELUS Communications Inc. provides coverage to 99% of Canadians over their network with High Speed Packet Access (HSPA), 4G LTE, CDMA and Integrated Digital Enhanced Network (iDEN) network technologies nationwide, in all major urban areas.[35] TELUS currently serves 7.34 million subscribers, representing 27.14% of the total market.

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[33] http://about.telus.com/community/english/news_centre/company_overview/company_history

[34] QSI Consulting. The State of Wireless technologies in Canada, 2007 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/dgtp-002-07-bell-Appendix-4.pdf/$FILE/dgtp-002-07-bell-Appendix-4.pdf

[35] 2011 TELUS Communications Inc.Annual Report

2.2.3.2 Bell Canada Enterprises Inc.

Bell Canada Enterprises Inc. (BCE) dates back to 1877, when Alexander Graham Bell assigned 75% of Canadian telephone patent rights to his father, Melville Bell, who proceeded to start up a Canadian telecommunications business with his friend Thomas Henderson.[36] BCE was originally a cable operator before starting wireless operations in Canada in 1985. Bell Canada is currently the largest telecommunications company in Canada with $19.4 billion in revenue in 2011.[37]

Bell Mobility is Bell Canada's subsidiary that operates the wireless spectrum assigned to BCE. It has been operating in the Canadian market since 1985, and in 2011 reached a total number of subscribers of 7.57 million, representing a market share of 27.63%. Bell Mobility's wireless coverage extends to more than 97% of the total population of Canada, providing multiple services that range from CDMA to LTE services.[38]

Their innovations in the mobile wireless industry include being the first carrier to provide "mobile movies", offering North America's first inter-operable picture messaging service (with Sprint), first inter-carrier mobile text messaging (with Microcell and Rogers), first instant messaging service available on a digital PCS phone, and Canada's first phone to home video messaging, first music video ringtones, first

[36] http://www.bce.ca/aboutbce/history/
[37] 2011 BCE.Annual Report
[38] QSI Consulting. The State of Wireless technologies in Canada, 2007 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/dgtp-002-07-bell-Appendix-4.pdf/$FILE/dgtp-002-07-bell-Appendix-4.pdf

streaming video clip service, first mobile phone with built in FM transmitter and first colour display mobile phone.[39]

2.2.3.3 Rogers Communications Inc.

Rogers Communications Inc. started when broadcasting entrepreneur Edward S. Rogers became majority shareholder of Canadian Cablesystems Limited, renaming the company "Rogers Cablesystems Inc" two years later.[40] In 1985, Rogers Communications participated as an investor in the start-up of wireless telecommunications operator Cantel (renamed Rogers Wireless in 1993). In 2004, Rogers bought up AT&T's interest in Rogers Wireless for $1.8 billion and one week later announced a $1.6 billion deal to purchase wireless provider Microcell (commercially known as Fido).[41] These moves meant that Rogers became the number one carrier in Ontario and the second largest in the remaining provinces at the time. [42]

Rogers Wireless has a history of innovations in the mobile wireless industry. It was the first and only carrier in North America to offer video calling. Rogers was also the first carrier in North America to debut HSDPA (a high speed data mobile wireless technology), the first to implement downloadable music to a cell phone, the first to offer a Name Display feature, the first to provide a mobile podcast service and the first to implement a commercial digital wireless service, and the first Canadian provider to allow

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[39] QSI Consulting. The State of Wireless technologies in Canada, 2007 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/dgtp-002-07-bell-Appendix-4.pdf/$FILE/dgtp-002-07-bell-Appendix-4.pdf

[40] http://www.thecanadianencyclopedia.com/articles/rogers-communications

[41] http://your.rogers.com/aboutrogers/historyofrogers/overview.asp

[42] Competition Bureau. Acquisition of Microcell Telecommunications Inc. by Rogers Wireless Communications Inc., 2005 from http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/00257.html

access to BlackBerry wireless services through Nokia phones.[43] Rogers currently offers coverage for 95% of the Canadian population and has 34.05% of market share with 9.33 million wireless subscribers.[44]

2.2.4 Subscribers and Market Penetration

Wireless penetration has increased steadily over the last years, according to the CRTC; there were 27.4 million subscribers in Canada in 2011, representing a 77.8% of the population and an increase of 6% over 2010 numbers.[45] Market penetration is an indicator that wireless providers constantly monitor, as sales of new devices and acquisition of new customers become difficult on locations that have high market penetration rates. Table 2 represents the current coverage and penetration rates by province in 2011.

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[43] QSI Consulting. The State of Wireless technologies in Canada, 2007 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/dgtp-002-07-bell-Appendix-4.pdf/$FILE/dgtp-002-07-bell-Appendix-4.pdf

[44] http://www.rogers.com

[45] http://www.crtc.gc.ca/eng/publications/reports/PolicyMonitoring/2012/cmr5.htm

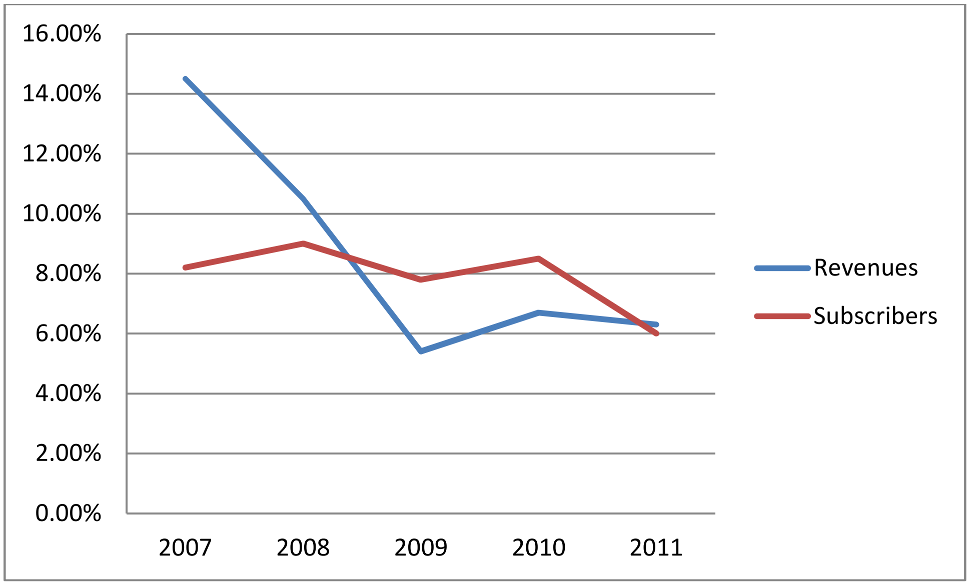
Table 2: Coverage and Penetration by Province (2011)

Province	Wireless Coverage	HSPA Coverage	LTE Coverage	Penetration Rate
British Columbia	99%	98.8%	51.6%	81%
Alberta	99.8%	99.8%	16%	97.1%
Saskatchewan	99.2%	95.7%	-	78%
Manitoba	98.5%	97.8%	-	74.2%
Ontario	99.8%	99.7%	61%	80.9%
Quebec	99.2%	99.1%	47.9%	65%
New Brunswick	99.8%	99.5%	-	68.2%
Prince Edward Island	100%	99.6%	-	65.9%
Nova Scotia	99.9%	99.7%	36.1%	74.2%
Newfoundland and Labrador	96.9%	96.3%	24.4%	74.2%
The North	66.4%	47.9%	36.7%	7.6%
Canada	99.3%	99%	44.7%	77.8%

Source: CRTC Communications Monitoring Report, 2012

Overall however, market growth has been slowing, from 14.5% in 2009-2010, to 6.3% in 2010-2011 (CRTC, 2011). Figure 4 shows the number of subscribers and industry revenue year on year from 2007 to 2011, and it can be seen that cellular carriers are starting to struggle to find new customers as industry penetration reaches an all-time high. With no new users, data consumptions growing exponentially, and customers demanding faster data rates without big increases in their monthly bills, companies are seeing their network costs per subscriber increase rapidly.

Figure 4: Wireless Revenue and Subscriber Growth Rates



Source: Adapted from CRTC Communications Monitoring Report, 2012

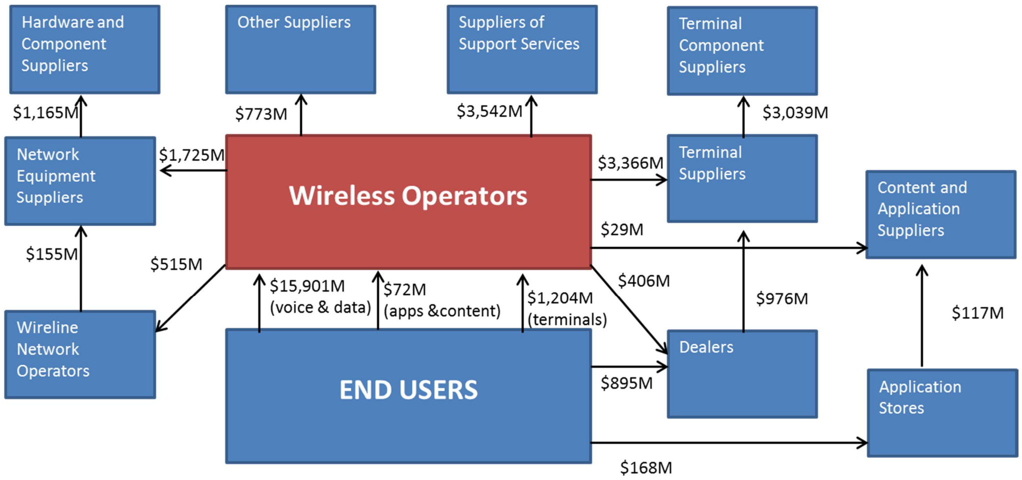
2.2.5 Market Value

The wireless industry has grown fast from its inception in 1983 and its initial entry into the Canadian market in 1985. It now contributes $43 billion to Canada's economy and supports over 260,000 jobs, as at 2012 (CWTA, 2012). By the end of 2011, mobile users had reached a high of 25.9 million, serving 84% of Canadian households.[46]

Wireless revenue in the industry is composed of direct and indirect services. Direct services include the main goods that consumers pay for. These include payments for voice and data services, for applications and data content and for the purchase of terminals and accessories. Indirect services include network equipment, transport and backhaul lease rentals and other support services provided. Figure 5 shows a simplified model of the wireless sector value chain.

[46] IAB Canada, Mobile In Canada: A Summary Of Current Facts + Trends, 2012, from http://www.iabcanada.com/wp-content/uploads/2012/04/IABCanada_MobileInCanada_041012_FINAL.pdf

Figure 5: Canada's Wireless Value Chain



Source: Adapted from OVUM, The Benefit to the Canadian Economy from the Wireless Telecommunications Industries: An Economic Impact Assessment. July 2012

Voice and data revenues are collected mainly through two methods: pre-paid or post-paid. Pre-paid services represent $777.2 million and 7% of the total revenue (CRTC, 2012), post-paid subscribers provide a subsidy on equipment costs, but require customers to sign a contract for a fixed period and to pay a monthly bill. Post-paid subscribers represent 78% of the total subscriber base, generating $13,317 million (CRTC, 2012). This distribution is particularly beneficial for wireless operators, as post-paid subscribers have higher than average revenue per user (ARPU) compared to pre-paid users. In 2011, ARPU for pre-paid customers was $16.49 and for post-paid customers was $67.21.[47]

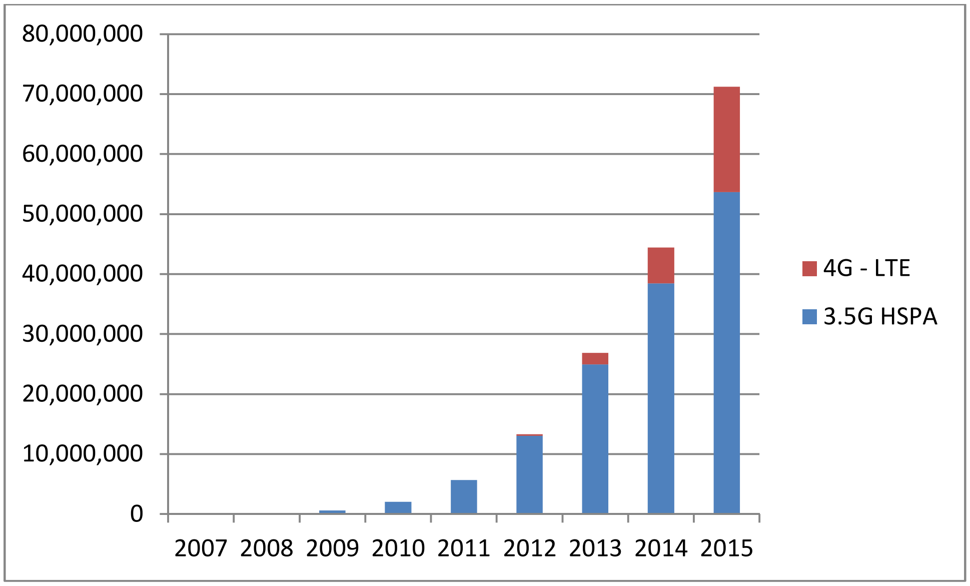
2.2.6 Market Forecasts and Need for Sites

Even though revenues and subscriber growth have been slowing, as shown in Figure 4, utilization is expected to grow. Data usage has been increasing exponentially

[47] Bell, Telus, Rogers Corporate Reports, 2011

and this trend is expected to continue. Figure 8 represents historical and expected Canadian data traffic volumes.

Figure 8: Traffic Volume in GigaBytes(GB)/month



Source: Created by the author using the data reported in the Cisco VNI Report, May 2012

The main reason for the increase in data usage is that new data services consume more network resources than regular voice calls. The following comparisons were made by CISCO to demonstrate the increasing consumption of network elements (based on monthly basic mobile data traffic):

- one smartphone = 35 basic phones
- one handheld gaming console = 60 basic phones
- one tablet = 121 basic phones
- one mobile phone projector = 300 basic phones
- one laptop = 498 basic phones

The combination of exponential rise in the resources required for data services, with smaller coverage footprints on data technologies (such as HSPA and LTE) deployed in higher frequency bands (2100MHz and 2600 MHz) and with an effective coverage radius of up to four times smaller than previous technologies, makes it necessary for the wireless companies to install new transmission sites and continue to generate creative solutions to keep up with the demand.

3: FIVE FORCES ANALYSIS

This section uses Michael Porter's (1979) five competitive forces framework to analyse the wireless telecommunications industry in Canada. This analysis will allow readers to understand the industry as a whole, the competition within the industry, the forces that help or hinder the companies in this industry to achieve their goals and the need for these competitors to improve customer service through product differentiation.

3.1 Competitors

The wireless telecommunications industry has traditionally been an oligopoly, with a limited number of incumbents dominating the market and the companies having some ability to set price. In the case of Canada, the wireless industry has traditionally seen only three major players: Rogers, Bell and TELUS. Recent efforts have been made by Industry Canada to increase competition by means of a recent frequency spectrum auction that brought three new competitors into the market. Even though the new entrants have been in Canada since the 2008 auction, Rogers, Bell and TELUS are still considered the incumbents; between them they have over 93.4% of the market share mainly due to the many advantages they have on the infrastructure deployed.

Companies within the industry have the potential to achieve sustainable competitive advantage through innovation. For example, as a result of making the decision to become the sole GSM provider in Canada, Rogers Wireless gained a comfortable 38% of overall market share in 2008, while Bell and TELUS attained 27%

each.[48] Bell and TELUS were also the only two companies to offer the iPhone during its first year of launch in Canada. However, rivalry between competitors is high, with Rogers' market share decreasing to 35% by 2011. Competition continues to become harder in this market as it nears saturation level and the only way of gaining new customers is by tempting them away from the other carriers.

3.2 Threat of Substitution

The threat of substitution in this market is medium to low; the technologies threatening the industry are Wi-Fi and fixed networks. Wi-Fi technology has been increasingly popular over recent years. A Wi-Fi network is setup when a network administrator creates an access point that can be accessed by any user that can receive a strong enough radio signal. A Wi-Fi network connection operates as a wireless Ethernet, providing service over short distances, typically between 50 to 150 meters.[49] This technology has been successfully adopted in recent years, which has led to a drop in the deployment costs, from $750 for a installing Wi-Fi router in 1992 (Salam, 2004), to $20 in 2012.

As data usage in the cellular network grows, a technology that allows users to connect to the internet potentially for free, such as Wi-Fi, could be seen as a substitution threat. However, there is one mitigating factor. As the typical coverage radius of a Wi-Fi connection is small, several thousand Wi-Fi connections would have to be created in order to compete with the data mobility that a wireless operator can provide. This would require a significant amount of capital.

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[48] Company Reports, 2009

[49] TRA. WiFi Technology. July 2003, from http://www.tra.gov.eg/uploads/technical%20material/Wi-Fi%20report.pdf

Fixed networks could be another potential threat, through the deployment of technologies that could potentially replace radio base stations such as FEMTO cells. FEMTO cells provide a radio access interface as a common cellular base station towards user equipment (Hämäläinen, 2011). FEMTO cells would provide cellular coverage at home, acting as a portable cellular site that would be backhauled over an internet wire line connection. This solution would provide alternative voice and data services for users wherever there are FEMTO cells installed. Just as Wi-Fi, fixed networks would require capital investment to provide mobility to users. However the capital investment required would not be as high, since cable operators have already backhauled connections to domestic locations.

The main telecommunications industry incumbents have tried to mitigate these threats either by seeking to control a big part of the threat, such as Rogers, Bell and TELUS also becoming cable operators, or by owning a significant portion of the backhaul transport network for Wi-Fi technologies.

There are no technologies available at this time that provide the portability and coverage that cellular networks provide. However, technology evolves quickly and the threat of substitution can increase significantly over a short period if faster or cheaper technologies are deployed. Historically new technologies have been more expensive than existing ones; therefore, the relative price performance of any potential substitute technology will be poorer in the short term.

3.3 Bargaining Power of Buyers

The bargaining power of buyers in this market is low, as customers are faced with limited options based on the limited number of providers and few to no substitute products. Several wireless telecommunications companies have adopted a subsidized device strategy that binds the customer into a long-term contract, usually one to three years. The subsidy comes in the form of low cost phone equipment that otherwise would be unaffordable. This increases buyer switching costs since subscribers incur steep penalties to buy out of contracts, as the phone subsidy is usually part of an early cancellation fee.

The regulation of business practices for the telecommunications industry in Canada is carried out by the Canadian Wireless Telecommunications Association (CWTA), which has a voluntary code of conduct for its members regarding contracts, advertisements and customer complaints; however, there are no consequences for members who do not follow this code, and the significant number of consumer complaints about cell phone contracts suggests that enforceable consumer protection measures are needed.[50]

In addition, users have increasing dependency on wireless devices. Several studies show our growing dependency on phones. For instance, Michelle Hackman, a recent high school graduate in Long Island, NY, won a $75,000 prize in the Intel Science Talent Search with a research project investigating teens' attachment to their cell phones.[51] This

[50] Consumer Protection Office. Improving Consumer Protect in Cell Phone / Wireless Device Contracts. December 2010

[51] Ellen Gibson. Smartphone dependency: a growing obsession with gadgets. July 2011. From http://usatoday30.usatoday.com/news/health/medical/health/medical/mentalhealth/story/2011/07/Smartphone-dependency-a-growing-obsession-to-gadgets/49661286/1

dependency on devices is a factor in the bargaining power of consumers since the willingness to pay for the service will increase with more uses and applications subscribers rely on.

3.4 Bargaining Power of Suppliers

The bargaining power of suppliers is high in this industry. Suppliers are mainly equipment vendors, handset providers, landlords and the municipalities involved. There are a couple of factors that determine the overall bargaining power of suppliers in this market. First, if the ability to provide cellular coverage is impacted when the supplier decides to terminate the relationship with the company, or to degradate its service, then the supplier would have high power to bargain, as it would be affecting quality of service, which is the number one differentiation factor on the industry. Second, if the ability to gain new customers or to keep existing ones is compromised by the vendor decisions, then the supplier would have impact on the growth of the company, and as a result high bargaining power.

3.4.1 Equipment Vendors

Equipment vendors are the companies that provide the telecommunications equipment, such as radio base stations, telephony switches or microwave radios. Once equipment vendors are selected, a big financial commitment is made to the supplier, mainly because the entire infrastructure has to be purchased through the same vendor. The main providers of radio base station equipment are Cisco, Nortel, Ericsson and Nokia. Typically these systems are not compatible with each other, so that all upgrades and capacity additions to any one system must also be purchased from the same original provider. Since the only time companies switch vendors is when they roll out new technologies, equipment vendor relationships are a critical issue for the carriers. Supplier switching costs become significant and impossible to realise in some cases. For example, vendor costs represented around 30% of the network investments between 2009 and 2012 in the case study company.

3.4.2 Handset Providers

Handset providers are also very powerful and play a big role in the competitive landscape of telecommunications companies. With some variation dependant on the degree of success of a particular device, most manufacturers have the upper hand when negotiating deals with wireless carriers. For example, none of the Canadian wireless operators had any leverage over Apple's iPhone release, which was launched originally in June 2007 in the US, UK, France and Germany. In Canada, the iPhone was launched in July 2008, more than one year later, and all subsequent new versions released up to the 4S model were launched in Canada weeks or months after they are available in other countries.

Lately wireless retail stores are seeing a new type of competition: new retailers such as Apple and Samsung stores are threatening the traditional reach of wireless carriers to their customers by approaching customers directly and cutting out the carrier during the provider selection process. This gives handset manufacturer-retailers more bargaining power to deal with wireless companies.

3.4.3 Landlords

Landlords supply locations for the radio base equipment. They are typically divided into two main groups. Tower landlords rent a piece of their property to one company to construct a telecommunications tower. These are usually owners of large lots, for instance manufacturing companies, farmers, or the government in the case of crown land. Lease agreements are for the erection of a tower. Other telecommunications carriers wanting to share the tower have to write an agreement with the lease holding company.

Tower landlords can earn up to $75,000 a year, depending on the location of a tower.[52] Tower installations require municipal consultation and any tower installation over 15m height need to be approved by the relevant municipalities. Rooftop landlords are mainly multiple occupancy buildings such as strata corporations and commercial property owners. These landlords rent their roof space to one or more telecommunications companies for the location of antennas and cabinet equipment. Rooftop agreements are usually based on the number of antennas, and companies pay a monthly rate per antenna.

Wireless companies have found strata corporations are very difficult to deal with. According to the law, strata special resolutions require ¾ of the total votes in order to pass.[53] Wireless carriers are required to present the proposed installations at an annual or special general meeting to get them approved. There is not much incentive for landlords in a strata building to approve these leases; annual leases range from $1,000 to $3,000 a

[52] http://www.antennamgt.com/blog

[53] Province of British Columbia Guide 13 How to Create or Amend Bylaws and Rules from http://www.housing.gov.bc.ca/pub/stratapdf/Guide13.pdf

year per antenna.[54] In a 100 unit building that translates to about $10 per antenna per year for landlords.

Lately there has been an increase in resistance towards cellular transmission sites, such as towers and antenna locations. This has reduced the number of potential landlords, has driven up the rents for rooftop antennas, and in forcing carriers to comply with numerous design requests has also driven up the costs of implementation. Municipalities have been actively organizing to make the public aware of new installations and to impose new restrictions on cellular towers.

To make things worse, several companies have specialized in providing real estate solutions to landlords to help with telecommunications transmission site leasing negotiations and agreements. Some of the companies operating in Canada include the Canadian Wireless Landlord Association, Wireless Capital and Airwave, among others. The rise of these companies who act as an intermediary for the execution of leasing agreements is making acquisition costs more expensive for the carriers.

3.5 Barriers to Entry

Barriers to entry in the wireless market are high. Several factors contribute to this, such as spectrum allocation, economies of product differences, and the absolute cost of entering the industry. There is one vital resource that restricts operations in the wireless industry: wireless spectrum. Cellular carriers are only allowed to operate within a specific spectrum band in order to a) avoid interference with other carriers, and b) allow carriers to optimize RF utilization. Spectrum is very limited and is regulated by Industry Canada.

[54] http://www.antennamgt.com/blog

For this reason, the barriers to entry in this market are significantly high. Once the government assigns spectrum, the only way to get into the market is to acquire one of the licences controlled by another carrier.

Another barrier to entry relates to the economies that Rogers, Bell and TELUS achieve by also controlling cable companies. The infrastructure and capital required to own and operate a cable company are significant and unlikely to be matched by a new carrier. This plays a big role in the cellular industry, as backhaul transmission is required to transport a signal from the cellular site back to the public network. Without a fibre distribution channel, usually owned by the cable companies, the cellular providers are obliged to rent transmission lines from the incumbent operators.

The fact that the big three companies control cable operators also gives them a better opportunity to reach their customers in other ways. The operators have valuable information about customer usage patterns, billing and demographics. This allows these companies to offer their customers product bundles and packages. Bundling makes the client less likely to switch to another vendor for any other services, especially if the price of the bundle is competitive. Product bundling simplifies the billing process for the vendor since all the services are billed under one invoice. It also increases switching costs, by gaining brand equity and increasing customer loyalty.

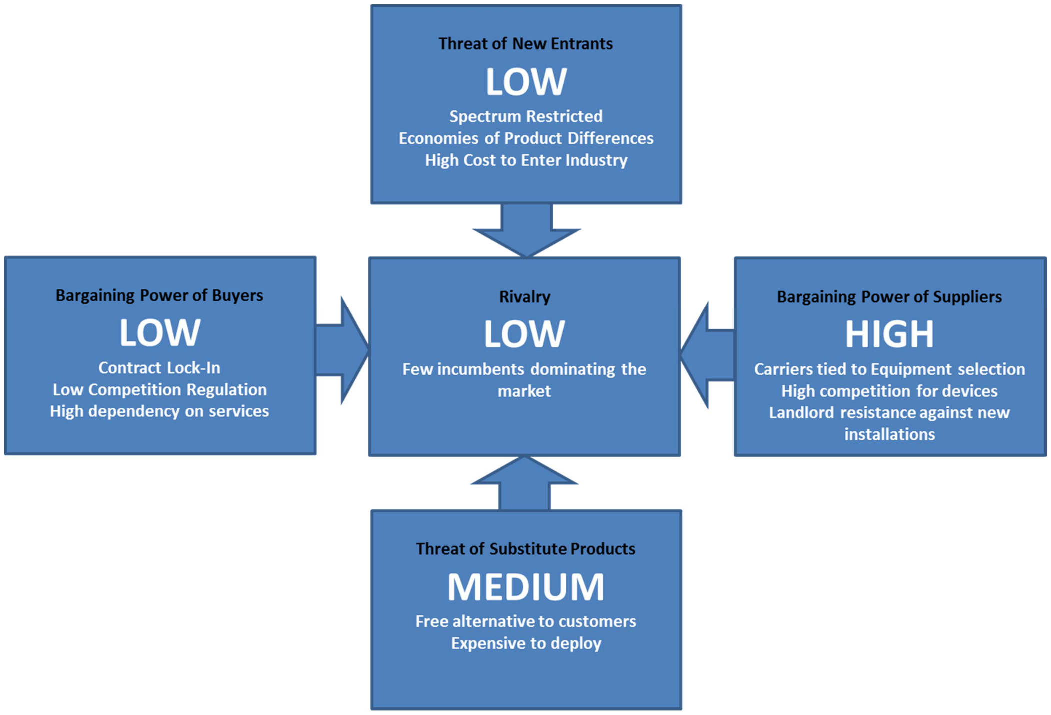
Absolute cost is another barrier to entry, not only in terms of the capital required to invest in a network, but also in terms of the limited number of permits and allowances that cities are willing to grant to towers and antenna installations. Therefore, it is typical for carriers to purchase and negotiate agreements between themselves. New entrants face stiff competition in trying to match locations in all sites where development permits have already been assigned.

3.6 Summary

The factors presented explain why cellular service in Canada is expensive. The industry has high barriers to entry and is considered an oligopoly, dominated by a few players who have some considerable ability to set up the price. They are protected against new entrants thanks to the limited frequency spectrum that they operate within, that is moreover controlled by the government. Investments in spectrum auctions are rare and are very capital intensive and this prohibits many companies from entering the market. While there are some technologies with the potential of challenging the cellular industry, such as Wi-Fi or FEMTO cells, the deployment costs of these are such that investors would require significant amounts of capital before these technologies could be considered as a threat.

Consumers have low bargaining power in this industry due to the lack of provider options and to consumers' own increasing dependency on cellular services. In contrast, suppliers have high bargaining power for various reasons: equipment vendors lock in carriers to their brands, handset manufacturers provide devices to many bigger markets than Canada such as the US, Europe or China, and landlords are oppose transmission site installations. Suppliers are driving the costs of the industry up. Finding a process that can help identify implementations that will provide a positive ROI is becoming increasingly relevant for carriers. Figure 6 provides a summary of the five industry forces discussed above.

Figure 6: Summary of Porter's Five Forces in the Canadian Wireless Industry



4: COMPANY BACKGROUND

The thesis is about proposing an improved site development process for a case study telecommunications company. The previous sections have described the industry and its environment. This section provides an overview of the organization and its vision, examines how the transmission site development process currently works within the company and proposes a redefined process to help the company better achieve its goals. The case study company name has been kept anonymous and all potentially identifying details and information have been omitted or changed to protect company confidentiality and competitive information. To facilitate discussion the case study company is referred to as Company X below.

4.1 Company Description

Company X is one of the leading telecommunications companies in Canada. With over 20,000 employees and more than 9 million customers all over the country,[55] X is a leading provider of wireless, cable TV, hi-speed internet and home phone services across Canada.

Company X focuses on its customers as its number one priority. This is demonstrated by the emphasis X puts on customers service and network improvements: the company invest 60% of their net income in seeking network improvements.[56] Innovation is another key pillar for company X and the organization has worked hard to

[55]Canadian Wireless Telecommunications Association (CWTA), 2011
[56]Company Reports, 2012

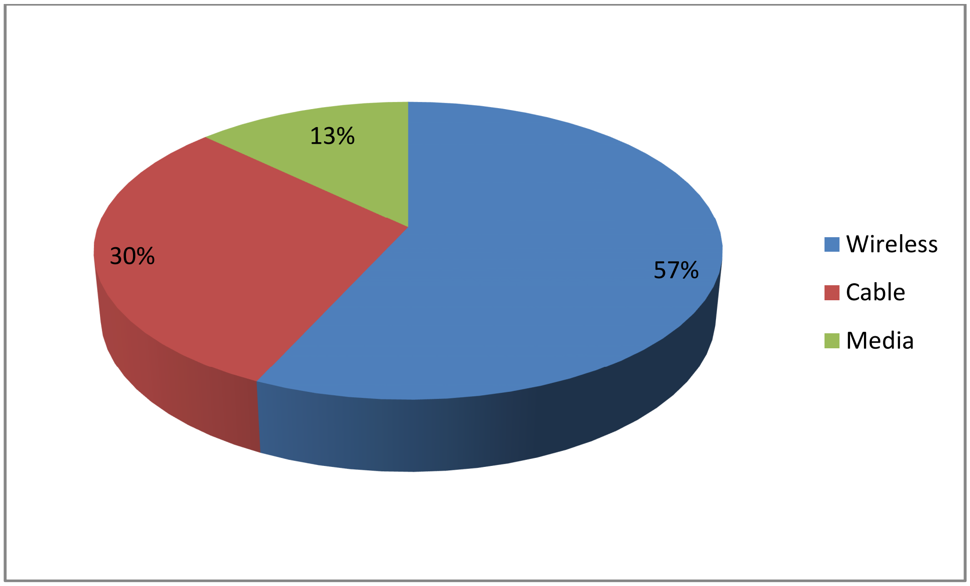
become the first to launch new technologies and to acquire new gadgets to enhance customer experience. The company strategy relies on providing high quality products to realise customer loyalty, so offering a positive customer experience is key to achieving differentiation from its competitors

4.2 Business Segments

Company X had a net revenue of $12.4 billion in the 2012 fiscal year and earnings before interest, taxes, depreciation and amortization (EBITDA) of $4.7 billion. The company has three main lines of business: wireless voice and data communications; cable home and business services; and media operations.

Figure 7 represents the company's revenue breakdown by business segment. Wireless revenue includes income through cellular service provision, data services, wireless activations, device sales and upgrades. Cable revenue includes cable television, high-speed internet access, home phone services, installations and upgrades, business-to-business services such as PDA systems and technical support, IP services and miscellaneous cable operations such as fibre and transmission lease to third parties telecommunications companies. Media revenue includes revenue from television channels, magazines and sports ticketing and merchandising

Figure 7: Revenue Distribution by Business Segment

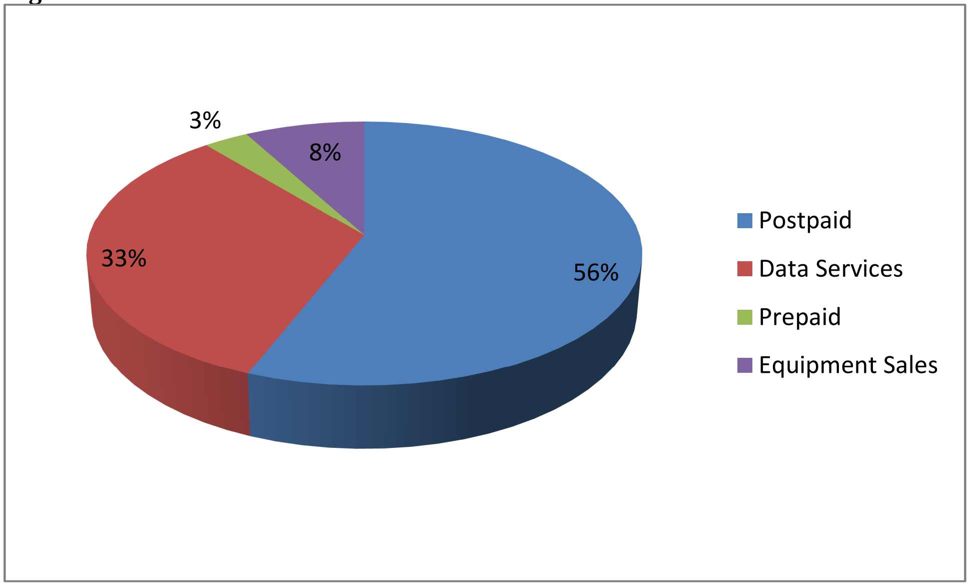


Source: Corporate Reports, 2011

4.3 Wireless Market

Wireless represents 57% of the total revenue of Company X, an income of $7.1 million in 2011. The company has achieved this by providing 2G, 3G and 4G services to prepaid and post-paid customers all across Canada. Figure 11 shows the distribution and sources of revenue of the cellular business segment of the company. Post-paid and prepaid figures represent income from wireless usage, roaming charges and service fees for the corresponding subscriber types; data service represents income from data usage revenue for all subscribers; and the equipment sales figure includes sales and upgrades of cellular equipment.

Figure 8: Wireless Revenue Distribution



Source: Corporate Reports, 2011

4.4 Key Performance Indicators

As shown in figure 8, the company has a high ratio of post-paid vs. prepaid revenue. Post-paid subscribers represent 83% of the total subscriber base, slightly above the industry average of 79%.[57] This ratio is particularly high due to the higher than average monthly revenue per user (ARPU) of a post-paid subscriber ($68.46 in 2011) compared to a prepaid subscriber ARPU ($15.91 in 2011). The ARPU figure is one of the key profitability indicators of the company. Bundling, discounting and bad customer service reduce the ARPU, while adding new services or features raises ARPU by increasing customer willingness to pay. Clearly then, innovation plays a huge role in increasing revenue per customer.

In 2011, data usage accounted for 33% of total revenue by the wireless segment, an amount of $2.4 billion in income. This segment has grown significantly in recent

[57]http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/cmr55.htm

years, having almost doubled from 2009 when it earned $1.3 billion in income for the company. The dramatic increase in revenue from data usage has implications for cell transmission site planning, as data sessions use up to 16 times more resources than a regular call.

The term *churn* is used to indicate the percentage of subscribers lost (or gained) by a carrier; typically prepaid subscribers carry a higher churn rate as they have few restrictions on how and when they leave their wireless plan; post-paid customers are attached to a fixed term contract. Table 3 represents churn rates, ARPU and total number of prepaid and post-paid subscribers and how the company did in 2011 compared to the industry average.

Table 3: KPI Benchmark Comparison

	Carrier X	Industry Average
Post-Paid		
Total Subscribers	7,574,000	19,139,326
Churn	1.32%	1.60%
ARPU	$70.26	$67.21
Pre-Paid		
Total Subscribers	1,761,000	4,467,121
Churn	3.64%	1.60%
ARPU	$16.02	$16.49

Source: Bell, TELUS, Rogers Corporate Reports, 2011

4.5 Investments in Capital

Wireless investments in property, plant and equipment (PP&E) totalled $1.2 billion in 2011. Of this total, over $900 million was dedicated to either constructing new cellular towers or upgrading existing ones through the country. This figure is over half of the capital expenditure (CAPEX) investments of the wireless industry as a whole, which in 2011 totalled $2 billion. [58] This investment also represents 16.8% of the revenue of the wireless segment. Table 4 shows the investments made by company X by expenditure category and as a percentage of overall revenue. These figures point to the significance of this current project whose aim is to help company X prioritize network investments in the best possible way.

Table 4: Capital Investments

Wireless Category	CAPEX investment (in millions)	Percentage of Wireless Income
Capacity	$628	8.8%
Quality	$250	3.5%
Other	$61	0.9%
IT	$253	3.6%
Total CAPEX	**$1,192**	**16.8%**

Source: Corporate Reports, 2011

Capital investment leads to improvement in the quality of the network, either by providing radio resources in congested areas, or by providing coverage to under-served subscribers. Either way, this improvement in quality results in an increase in perceived value, improving brand loyalty and brand equity.

4.6 Company Structure

Two departments within the organization are key to supporting the goal of improving brand loyalty. First, the marketing department targets customer awareness by reaching subscribers and spreading awareness of company innovations and brand

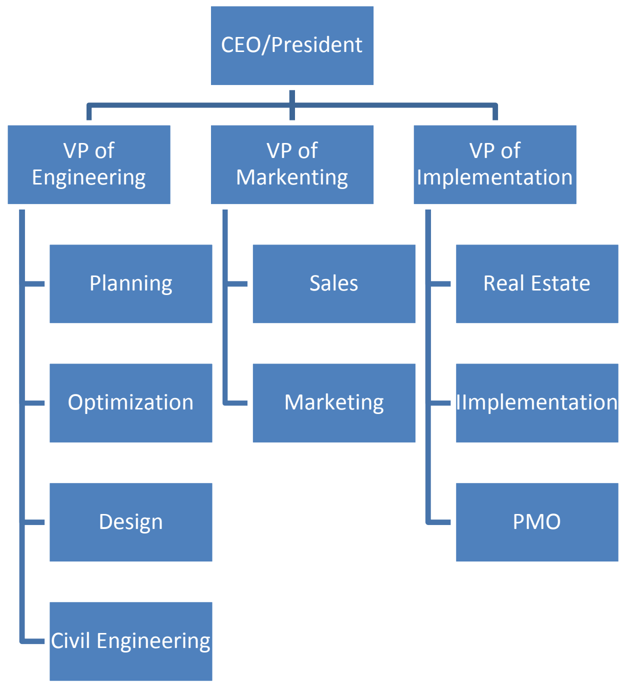
[58] http://www.crtc.gc.ca/eng/publications/reports/PolicyMonitoring/2011/cmr5.htm#n0

differentiation. Next, the engineering department is in charge of providing the best possible customer experience and meeting customers' expectations.

For the purpose of this project, only the new site development process within the engineering and implementation departments will be analysed. This process has a few internal stakeholders: the Planning Department, in charge of determining cellular requirements; the Optimization Department, in charge of monitoring the network; the Design Team, in charge of proposing solutions; the Civil Engineering Department, in charge of creating structural designs and specifications. The VP of Implementation is in charge of acquiring all required legal agreements necessary to finish a project through the Real Estate Department; and executing it through the corresponding Project Management Office (PMO) and Implementation Department.

Further analysis of this process and more details about how departments interact with each other are explained in the next chapter.

Figure 9: Simplified Organizational Structure



5: NEW SITE DEVELOPMENT PROCESS

This section describes in detail the planning process within the organization and how new equipment is deployed in the network. In particular it describes how capacity planning works within company X. The chapter closes with an overview of the new site development process in the organization, highlighting the current limitations of the process and potential agency problems that might arise.

5.1 Process Description

New technologies, such as 4G LTE require more capacity than ever before. As previously described, capacity comes from new radios and antennas in the BTS, that provide access to the subscribers in the network. The network planning department is in charge of determining capacity requirements and identifying the locations where additional radios or BTS will be needed. The new site build process starts with a flow of information to the planner of each geographic region. The information comes from the collection of traffic statistics, such as the amount of traffic carried per site, or the number of dropped calls per region. It also comes from other departments such as marketing or optimization that inform the planner what kind of growth is expected within the region as well as what special events are in the pipeline that would be likely to increase traffic more than usual.

The planner then prepares a document detailing the projected demand, capacity requirements and projected budgets to make the necessary improvements, for a time horizon over the next three years. The budget is then reviewed by senior management and depending on the capital expenditure strategy of the company a certain percentage of the requirements are approved for implementation.

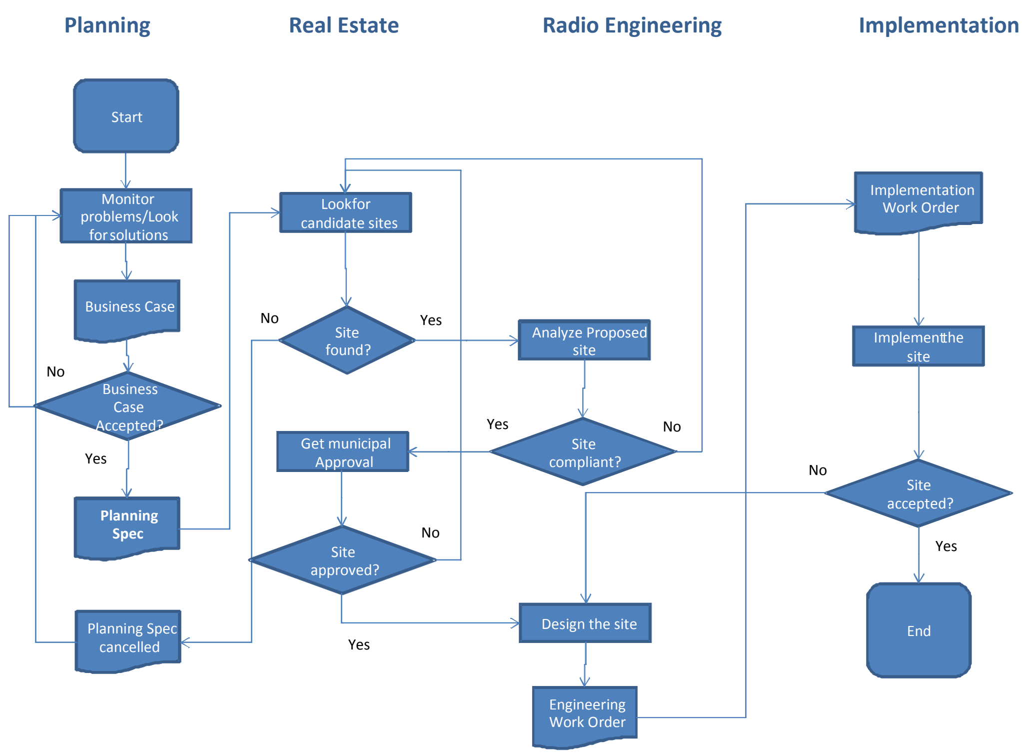
Once the requirements are approved, a planning specification document is released within the organization, with specific instructions on the ideal locations for siting the additional equipment required to meet the capacity needs. This triggers the real estate acquisition team to start working on securing agreements at each of the sites mentioned in the specification document, to allow the company to locate antennas and equipment at that property.

Before a landlord signs an agreement, the radio design team analyses the site and if it is compliant with the objectives set out in the specification document, an engineering qualification document will be issued to start the implementation process and sign the real estate deal. If the site is not in compliance with the specification, then the radio engineering department either apply for an exception acceptance, or disqualify the site in which case the real estate team have to look for another landlord. Once the agreement is signed, there is a municipal consultation process with the city or municipal authority, the general public is notified and permits are issued.

The site is declared Ready to Build once all permits are set in place and the site is placed in an acquired pool. Once a year, sites from the Ready to Build pool are reviewed by the network planning department, based on senior management input, to determine a build program for the year. Once the build program is ready, a full build document is issued for each site, to signal the requirements for the year.

The full build document triggers an implementation work order, what enables the construction process to start once the lease is signed. Construction can be as simple as inserting a board into an existing cabinet, or as complex as building a 50m tower in top of a mountain. Once construction is finished, the performance team measure the site and determine if it is suitable for integration in the network. If it is, a site acceptance document is generated signalling the end of the project and the creation of a new site providing new coverage and supporting capacity on the network. The process can be represented in the following flowchart.

Figure 10: Existing New Site Development Process



5.2 Current Process Limitations

The existing process has worked so far, with thousands of towers being built across the country between all the wireless carriers. However the cost of building site towers have been creeping up every year not only because of new technology deployment costs but also because landlords are now more reluctant to support cellular antennas on their properties, making real estate acquisition costs more expensive. With revenues shrinking in the wireless industry, it is important to place more emphasis on the expenditure of building additional sites in the network.

The process does however have a number of weak points. First, there is no defined process for controlling expenditure, mainly because costs are submitted too early in the process. What often happens is that there is no real tracking of how much a site is really going to cost until the last stages of the process, when the leases are negotiated and it is found that actual expenditure exceeds the budget. Considering that the average cell site cost is $436,000,[59] exceeding budget allocations significantly on a high number of sites will cost the company a substantial amount of money. While exceeding the budget might be unavoidable on some projects, the fact of not knowing how much the company has compromised on a project it might lead to its failure.

Second, there are no standard intervals for the construction process, as the implementation times vary largely between projects. This has led to a lack of follow up from the planning side of the business and a lack of accountability. Third, there is a time bottleneck in the process associated with the site acquisition consultation process with the municipalities. This stage can take as long as two years since there are political interests

[59] Canada Industry Statistics (CIS), 2012

involved, especially for controversial sites in active communities. In most instances, a problematic area involves a delay of several months before a location is ready for construction. With health and safety concerns and aesthetic issues becoming more important considerations, one can anticipate that delays at this stage will only get worse in the future.

Finally, there is no control regarding which property owners the real estate agents contact in order to sign an agreement. This has the potential of creating an agency problem when the interests of the agent are not aligned with the interests of the principal.

5.3 Agency Problems

In order to meet quality targets, the principal, in this case company X whose main objective is to build sites to match strategy in the most cost efficient way possible, allocates a certain amount of sites per year (Z) to be built. The real estate acquisition department within the company is in charge of acquiring at least that number from a pool that is three times that size. If the real estate department acquires at least Z sites, there is a productivity bonus for the managers.

As discussed above, the acquisition department receives a specification document containing the requirements of the cellular site and the boundaries of the area that has congestion problems. Based on this document, the analysts try to negotiate a deal with a willing landlord and make an application to the city for a permit to build the tower.

In recent years there has been a lot of resistance all across the country to the building of communication towers, resulting in a surge of problems and disputes between municipalities and wireless carriers. Real estate agents have had to invest much more time than normal in fighting such disputes and application processes for big cellular towers (over 50m height) now take from six months to a year longer than they did five years ago, especially in densely populated areas.

Real estate consultations for sites over 50m in height are town hall meetings. At these meetings, analysts have to deal with questions from the general public who are typically opposed to the construction of cell towers. The success rates of such consultation meetings are low, as approval is on the basis of achieving up to 75% concurrence; analysts on the whole prefer not to deal with this type of site.

The agency problem arises because the goal of the principal does not align with the goal of the agent. In this case, the goal of the principal (Company X) is to build the most cost efficient site possible, while the goal of the agent is to maximize the number of sites with the minimum effort possible. On top of this, the occurrence of a problem of this kind is hard to predict, as it is difficult to verify when a site will be impossible to secure. In addition, it is hard for the engineering department to reject lower sites, as prediction tools are not 100% accurate and there is not a ROI figure that determines whether acquired sites are suitable for the network.

6: PROPOSED NEW PROCESS

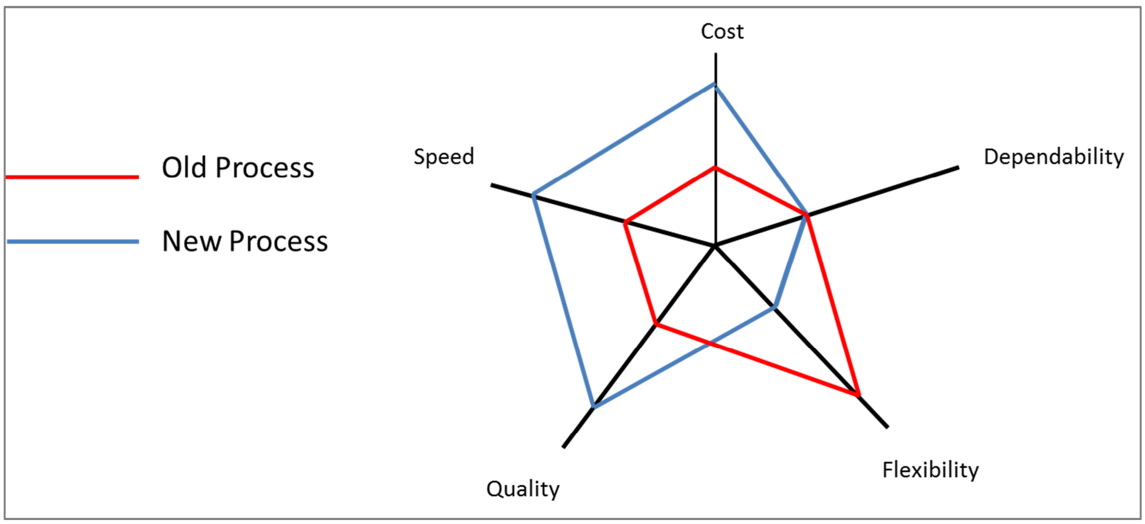
6.1 Addressing Top Issues

In order to optimize this process and maximize the value that every new site brings to the network, there are two major issues that need to be addressed. First, it is important to add control points to the activities that involve expenditures and to appoint a person responsible for analysing business cases for each proposed alternative. This would provide guidance to decision makers as to whether to proceed or to re-evaluate the chosen solutions.

Second, the real estate acquisition process has to begin earlier in the process, since it is a bottleneck. As discussed above, there is little the company can do to expedite the decision making process of the municipal or city council, as it is an external process that the company has little influence over. This process has to start even before a problem in the network has been identified. If a problem in the network does arise, having to wait for a decision for six months to two years becomes too problematic. A proposed solution would be to start acquiring as many sites as possible three to five years earlier, with guidance from the planning and engineering departments. Since there is little or no cost associated with maintaining a lease that has not been exercised, there is no significant overhead involved in making this change.

There are five variables that are relevant when monitoring the changes that are being proposed for this new process. The first is cost in terms of how much the new site costs; the second is quality in terms of what coverage and capacity improvements the location will bring to the network; the third is speed in terms of how fast the new site could be brought in service once a problem is identified; the fourth is flexibility in terms of the ability of people in the process to make changes and create out of the box solutions when designing or implementing new sites; finally the fifth is dependability in terms of being able to constantly provide new site capacity relief every time there is a problem in the network. The following diagram represents how the proposed solution would compare with the old process in terms of cost, speed, dependability, quality and flexibility. The new process was found to be better in all variables except on flexibility.

Figure 11: Polar Diagram

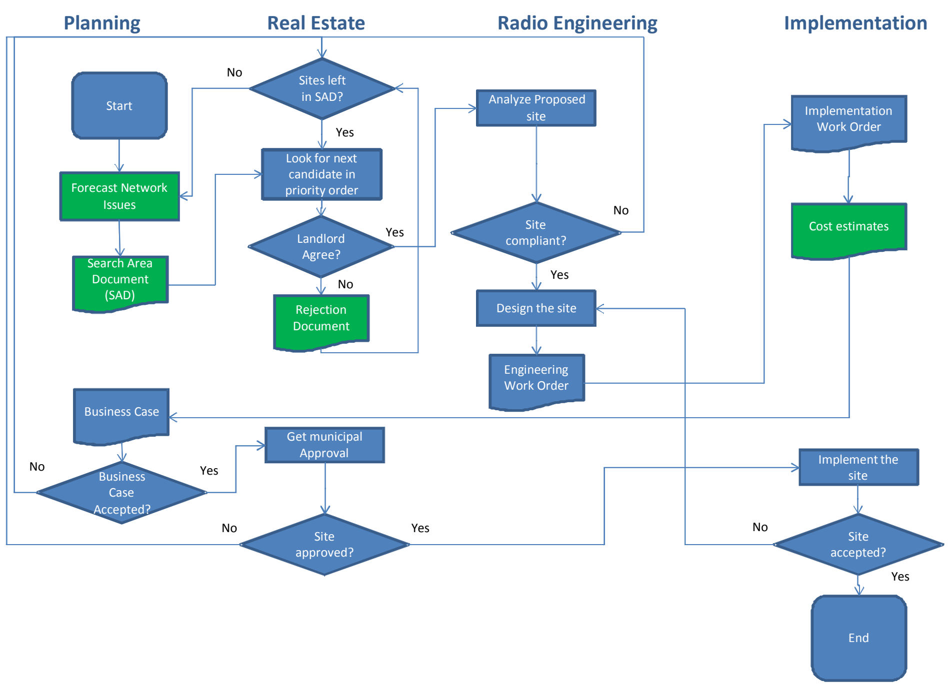


By revamping the process, costs expenditure are expected to improve as there will be someone responsible for the capital spend; speed of implementation will increase as the real estate process will start in advance; flexibility will decrease since the solutions will not be tailored to the problem, given the fact that they will be in place before the problem happens; quality will improve as the real estate acquisition specialist will receive feedback from engineering before securing the site, resulting in the acquisition of sites that provide better coverage; and lastly dependability will remain constant, since the main constraint preventing the acquisition of new sites, municipal and political approval, remains the same.

6.2 Proposed Process

The proposed process can be seen in the following diagram, major changes in the process are highlighted in green.

Figure 12: Proposed Process



Moving the real estate acquisition process to the beginning of the process and starting it a couple of years before sites are needed, reduces the bottleneck problem and increases the company's ability to respond quickly to problems. The real estate analyst will work with a search area document that will be created with a five year forecast in mind. In this way there is "insurance" that, by the time a problem occurs, there has been enough time given to the real estate agent to deal with the landlords and the municipalities. On average, this change is expected to save the new site development process between three to six months each year, as the real estate agreements are expected to be completed before the year of implementation.

The proposed search area document will provide specific directions to the real estate department as to which landlords to approach. Previously, the real estate department was presented with a planning specification document that reflected the issue but provided no guidance for the solution. The new search area document will give the real estate department a ranking of sites that would satisfy the company's objectives and the real estate team deal with them on the basis of priority.

To guarantee that the real estate analyst works in alignment with the top priorities of the company, and that the best quality sites are acquired, a rejection document will be generated for every site rejected by the landlord. This will ensure that there is more documentation on which sites have been rejected, will reduce the chance that a landlord is contacted twice and will result in a record that proves that the best options for site candidates were exhausted.

Finally, the business case and ROI calculations will now be based on real estimates, after the engineering and implementation work orders are issued. This will enable a better understanding of costs, will allow senior management to make better decisions and will reduce the current problem of costs creeping up once the site is designed. This will also help to reduce any surprise costs and will enable the implementation team to work within the budget. Average cost will likely be reduced with this change as there are going to be more business cases rejected when a site is too complex or too expensive to build and has sub-optimal value to the company.

It is important to create a balanced score card for this process and to ensure that goals include financial, external, operational and development dimensions. This would allow the process to be measured by its performance and sustainability. Examples of targets that can be set include:

- Financial: Optimize capital expenditure by achieving an average cost per site of less than $350,000
- External: Improve customer satisfaction by achieving less than 0.1% dropped calls
- Operational: Improve success of acquisition by having no more than 10% landlord rejection
- Development: Improve forecasting by achieving zero reworked search area documents

6.3 Solving the Agency Issue

In order to increase the real estate agents' motivation to acquire the best locations for the company, it is important to align their goals with the company goals and to make the agents prioritize sites that maximize the value of the company by compensating for locations with a high ROI. An incentive for this would be rewarding according to the total number of calls that a particular site handles after it is built, since this is directly proportional to the goals of the company: the higher the traffic, the higher the revenue. A system where a real estate analyst is paid for traffic generated by the sites they acquired will provide them with a further incentive to acquire other such relevant locations. It is possible to write a contract where the new compensation (W') is a factor of the new base salary (A') plus a constant (b') times the traffic generated by the traffic after it is put in service (T), so $W' = A' + b'T$.

Since the real estate manager already receives a contract such that W(Current contract) = W(Current Base salary) + bN (Current incentive based of number of sites acquired), the new contract has to be structured such that $W' > W$ in order to increase the likelihood that the manager will accept the new contract. Since the new contract creates new risks for the agent, as its compensation now depends on customer traffic, the contract must be structured such that $b'T > bN$ in order to be give an incentive to the agent to take this risk.

The acquisition process for large telecommunications companies is difficult to reward, mainly because it is difficult to monitor whether the agents do a good or a bad job of acquiring a site, since acquisitions are based on negotiation strategies that may or not be the adequate ones for each case. This could result in the agent acquiring sites with a negative return on investment. Rewarding the agents according to a measure related directly to the income of the company, such as call traffic, will reduce the motivation of agents to act against the interests of the firm.

7: CONCLUSION

The acquisition process in any wireless telecommunications company is vital for the sustainability of the company in this market. It provides capacity to support the network growth and the addition of new subscribers; and at the same time supports a degree of quality that could potentially give the company competitive advantages over other companies. The current process within company X, while delivering results, compromises the capital expenditures made and results in higher than ideal costs principally because there are few controls built into the process. Doing financial analysis from the beginning of the project just before the construction starts, would make it easier for the decision makers to make informed decisions and to approve or reject projects with low value and high costs for the company. Starting the real estate acquisition process earlier would improve deliverability of sites, and adding controls as to which landlords are targeted will improve the quality of the sites acquired. By implementing these changes, the company would be able to spend the capital dedicated for expansions in a more intelligent way, what would lead to a more efficient use of company X’s resources.

BIBLIOGRAPHY

Abtahi M., Valaee S.& Tabiani. M. (2010, Oct). Comparison of CDMA and TDMA in AWGN channels. Scientia Iranica, Vol 7, Nos 3&4, pp 197-204. Sharif University of technology

Andersen Consulting. (1998). The GSM-CDMA Economic Study. Retreived September 2012 from http://sss-mag.com/pdf/fivexsum.pdf

Antenna Management. Safety Code 6. Retreived September 2012 from http://www.antennamgt.com/antenna-resources/safety-code-6

Arthur D. Little Consulting. (2010). Cost Reduction in the Telecom Industry. Retreived September 2012 from http://www.adlittle.com/downloads/tx_adlreports/ADL_Cost_Reduction_Telecom_Industry.pdf

Bell Canada Enterprises. (2011). BCE 2011 Annual Report. Retreived October 2012 from http://www.bce.ca/investors/investoroverview/?Locale=en_USfinancialperformance/annualreporting/index.php

Brunner E. (2000). Cellular Communications Tutorial. Analog Devices. Retreived September 2012 from http://sl-div-bi-pb.web.cern.ch/sl-div-bi-pb/PrivatePBpage/electronics/Electronics-Misc/AnDevCourse/Pres-A1%20Comms_Tutorial.pdf

Canada Newswire. (2011, Dec). Canada's largest and fastest LTE network - the Rogers LTE network is now live in more cities surrounding Toronto and Vancouver. Retreived September 2012 from http://www.newswire.ca/en/story/893679/canada-s-largest-and-fastest-lte-network-the-rogers-lte-network-is-now-live-in-more-cities-surrounding-toronto-and-vancouver

Canada Newswire. (2011, Feb).WIND MOBILE announces successful 4G live trial. Retreived September 2012 from http://www.newswire.ca/fr/story/796063/wind-mobile-announces-successful-4g-live-trial

Capgemini Consulting. (2011). LTE Opportunities and challenges for Telcos. Telecom & Media Insights. Issue 58.

CBC. (1985, Jun). Canada goes Cellular, Retreived September 2012 from http://www.cbc.ca/player/Digital+Archives/Science+and+Technology/Applied+Science/ID/1767289567/?sort=MostPopular

CISCO. (2012, May). Visual Networking Index . Retreived September 2012 from http://www.cisco.com/en/US/netsol/ns827/networking_solutions_sub_solution.html

Competition Bureau. (2005). Acquisition of Microcell Telecommunications Inc. by Rogers Wireless Communications Inc. Retreived September 2012 from http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/00257.html

Consumer Protection Office. (2010, Dec). Improving Consumer Protect in Cell Phone / Wireless Device Contracts.

CRTC. (2007, May). Broadcasting Public Notice.Retreived September 2012, from http://www.crtc.gc.ca/eng/archive/2007/pb2007-53.htm

CRTC. (2009). Communications Monitoring Report. Retreived September 2012 from http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/cmr55.htm

CRTC. (2011). Communications Monitoring Report. Retreived September 2012 from http://www.crtc.gc.ca/eng/publications/reports/PolicyMonitoring/2011/cmr5.htm#n0

CRTC. (2012). Communications Monitoring Report. Retreived September 2012 from http://www.crtc.gc.ca/eng/publications/reports/PolicyMonitoring/2012/cmr5.htm

CRTC. (2012). Communications Monitoring Report. Retreived September 2012 from http://www.crtc.gc.ca/eng/publications/reports/PolicyMonitoring/2012/cmr5.htm

CRTC. (2012, Sep). About CRTC. Retreived September 2012 from web site http://www.crtc.gc.ca/eng/backgrnd/brochures/b29903.htm

Ericsson. (1999). BSS Integration. Retreived September 2012 from http://cosconor.fr/GSM/Divers/Equipment/Ericsson/Bss%20integration.pdf

Ericsson. (2002). GPRS Dimensioning and Performance. Retreived September 2012 from http://oskarena.hlavac.cz/dokumenty/02%20gprs%20radio%20network%20configuration.pdf

Ericsson. (2012, Feb). Traffic and data market report. Retreived September 2012 from http://www.ericsson.com/res/docs/2012/tmd_report_feb_web.pdf

Gibson E. (2011 July). Smartphone dependency: a growing obsession with gadgets. Retreived September 2012 from http://usatoday30.usatoday.com/news/health/medical/health/medical/mentalhealth/story/2011/07/Smartphone-dependency-a-growing-obsession-to-gadgets/49661286/1

Global Star. CDMA Technology Retreived September 2012 from http://www.satphonezone.com/cdmatechnology.html

Hämäläinen J. (2011, Jul). Femtocells: Technology and Developments. Retreived September 2012 from http://www.cwc.oulu.fi/summerschool2011/Femtocells_Hamalainen2011.pdf

IAB Canada. (2012). Mobile In Canada: A Summary Of Current Facts + Trends. Retreived September 2012 from http://www.iabcanada.com/wp-content/uploads/2012/04/IABCanada_MobileInCanada_041012_FINAL.pdf

Industry Canada. (2002, Dec). Triangle Mountain Antenna Towers Review, Retreived September 2012 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08010.html

Industry Canada. (2010). A Brief History of Cellular and PCS Licensing.

Industry Canada. (2010). Auction of Spectrum Licences for Advanced Wireless Services and Other Spectrum in the 2 GHz Range: Licence Winners, Retreived September 2012 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09002.html

Industry Canada. (2011, Jul). Canadian Table of Frequency Allocations. Retreived September 2011 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf01678.html

Industry Canada. (2011, Nov). TAFL Industry Canada Database. Retreived September 2012 from http://www.ic.gc.ca/eic/site/tafl-ltaf.nsf/eng/home

Industry Canada. (2012). Telecommunications Service in Canada: An Industry Overview. Retreived September 2012 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf06283.html

Industry Canada. (2012, Aug). Canadian Municipalities and the Regulation of Radio Antennae and their Support Structures. Retreived Septemer 2012 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09389.html

Industry Canada. (2012, Aug). Consultation on a Policy and Technical Framework for the 700 MHz Band and Aspects Related to Commercial Mobile Spectrum. Retreived September 2012 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09949.html

JDSU. (2010). Mobile Networks Tutorial. Retreived September 2012 from http://www.jdsu.com/ProductLiterature/Mobile_Networks_Tutorial.pdf

Kisiel J. MSU. (2008, Apr). CDMA and TDMA Cellular Communication. Retreived September 2012 from https://www.msu.edu/~kisielwi/CDMA%20and%20TDMA%20Cellular%20Communications.pdf

Korhonen J. (2004). HSDPA – An Introduction. TTPCOM. Retreoved September 2012 from http://www.dcc.fc.up.pt/~mrodrigues/teaching/wn0809/wn0708_additions2.pdf

Lindberg K. & Sagerholm B. Televerket, Sweden (1988, Jun). Trunk Reservation and Grade of Service Issues in Circuit Switched Integrated Networks. Retreived September 2012 from http://www.i-teletraffic.org/fileadmin/ITCBibDatabase/1988/lindberg885.pdf

Liu I. & Ying B. (2009, May). TD-LTE and its measurements. RF Globalnet. Retreived September 2012 from http://www.home.agilent.com/upload/cmc_upload/All/AgilentLTEarticle.pdf?&cc=CA&lc=eng

Lofberg U. (2011, Feb). In-Building Mobile Coverage Systems and Deployment. BICSI. Retreived September 2012 from https://www.bicsi.org/uploadedfiles/pdfs/conferences/mea_11_04_dubai/15-Ulf%20Lofberg%20-%20CommScope%20-%20In%20Building%20Wireless.pdf

McArthur K. (2011, Feb). Rogers confirms LTE deployment; invests in Canada’s “Digital Fast Lane”. Retreived September 2011 from http://redboard.rogers.com/2011/rogers-confirms-lte-deployment-invests-in-canadas-digital-fast-lane/

Mobilicity, (2012, June). Mobilicity moving to 4G. Retreived September 2012 from http://mobilicity.ca/newsroom/mobilicity-moving-4g/

Nowak P. CBC, (2008, Jul). Telus, Bell to switch cellphone technology: report. Retreived September 2012 from http://www.cbc.ca/news/technology/story/2008/07/21/tech-cellphones.html

OVUM, (2012, Jul). The Benefit to the Canadian Economy from the Wireless Telecommunications Industries: An Economic Impact Assessment. Retreived September 2012 from http://cwta.ca/wordpress/wp-content/uploads/2012/06/Ovum2012.pdf

Pandey S. TIFR, (2009, Apr). 3GPP Wireless Standard. Retreived September 2012 from http://www.tcs.tifr.res.in/~shishir/Files/3GPP.pdf

Pashtan, A. (2005). Wireless Terrestrial Communications: Cellular Telephony. Telecommunications systems and Technologies – Vol I. EOLSS. Retreived September 2012 from http://www.eolss.net/Sample-Chapters/C05/E6-108-08-00.pdf

Persaud, C. Marketnews, (2009, Oct). Bell, Telus Prepare for 3G HSPA Network Launch. Retreived September 2012 from http://www.marketnews.ca/content/index/page?pid=6106

Porter, M. (1979). How Competitive Forces Shape Strategy. Harvard Business Review. Volume 57, Issue 2.

Province of British Columbia, (2010, Apr). Guide 13 How to Create or Amend Bylaws and Rules. Retreived September 2012 from http://www.housing.gov.bc.ca/pub/stratapdf/Guide13.pdf

QSI Consulting, (2007). The State of Wireless technologies in Canada. Retreived September 2012 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/dgtp-002-07-bell-Appendix-4.pdf/$FILE/dgtp-002-07-bell-Appendix-4.pdf

Quorus Consulting, (2012, Apr). 2011 Cell Phone Consumer Attitudes Study. CWTA. Retreived September 2012, from http://www.cwta.ca/CWTASite/english/facts_figures_downloads/Consumer2011.pdf

Rappaport T. IEEE Press, (2002). Wireless Communications: Principles and Practice (2nd Edition). Prentice Hall PTR.

Red Mobile Consulting (2011, Nov). Study of Future Demand for Radio Spectrum in Canada 2011-2015. Retreived September 2012 from http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10275.html

Rogers Communications, (2011). RCI 2011 Annual Report. Retreived October 2012 from http://www.zinio.com/reader.jsp?issue=416213392&o=ext

Sachs J., Balon T. & Meyer M. (1999, Oct). Congestion Control in WCDMA with Respect to Different Service Classes. Retreived September 2012 from http://www.google.ca/url?sa=t&rct=j&q=sachs%20j.%2C%20balon%20t.%20%26%20meyer%20m.%20(1999%2C%20oct).%20congestion%20control%20in%20wcdma%20with%20respect%20to%20different%20service%20classes.&source=web&cd=1&cad=rja&ved=0CC0QFjAA&url=http%3A%2F%2Fciteseerx.ist.psu.edu%2Fviewdoc%2Fdownload%3Fdoi%3D10.1.1.11.8383%26rep%3Drep1%26type%3Dpdf&ei=gzu9UKC_EeTYyAH52oGQCQ&usg=AFQjCNE4UB58W7pEDBNZKmTxfNr6cS1dWw

Salam, A. (2004, Feb). Wi-FiTechnology Overview. Retreived September 2012 from http://wireless.ictp.it/school_2004/lectures/ermanno/Wi-Fi_overview.pdf

SFU Cell GIS Group, (2000, March). SFU Hazard Vulnerability Model, Retreived September 2012 from http://www.sfu.ca/geog452spring00/project5/gallery.html

Telecommunications Industry Association. Glossary of Telecommunication Terms. Retrieved September 2012 from http://www.tiaonline.org/resources/telecom-glossary

TELUS Communications, (2011). TELUS Communications 2011 Annual Report. Retreived October 2012 from http://about.telus.com/investors/annualreport2011/?lang=en

The Globe and Mail, (2010, Jul). A phone so big that came with its own baggage. Retreived September 2012 from http://www.theglobeandmail.com/report-on-business/a-phone-so-big-it-came-with-its-own-luggage/article1389639/

TRA (2003). WiFi Technology. Retreived September 2012 from http://www.tra.gov.eg/uploads/technical%20material/Wi-Fi%20report.pdf

Young, W.R. AT&T, (1979, Jan). Advanced Mobile Phone Service: Introduction, Background and Objectives. The Bell System Technical Journal, Vol 58, No 1.

Zacks Investment Research (2012, Jul). Rogers Wireless. Retreived September 2012 from http://www.zacks.com/stock/research/RCI/company-reports