THE VANCOUVER WIRELESS
TELECOMMUNICATION INDUSTRY: A CLUSTER
ANALYSIS

by

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Diplome d’Ingénieur d’État, Université Hassan II, 1992

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The Vancouver wireless telecommunication industry: a cluster analysis

Author:

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ABSTRACT

The global wireless telecommunication is one of the world’s fastest growing industries. Future growth will be fuelled by both enterprise and mobile workforce applications. The changing industry landscape provides opportunities for new firms and nations to benefit substantially from its growth and dynamism. In this context, this project’s objective is to study the Vancouver (Canada) wireless telecommunication industry cluster from different angles while focusing on micro-level firm linkages and company strategies to analyze the development of the cluster and its association with supporting infrastructure.

The analysis of four metropolitan wireless industry clusters in the Bay Area (California, US), Helsinki (Finland), Calgary and Ottawa (Canada), reveals a wide variety in structure, origin, internal dynamics and level of maturity. This variety suggests that there may be no universal formula or strategy to create and make a cluster successful. The evidence examined in this project not only confirms the presence of a wireless cluster in Vancouver, but shows that it is fully engaged in the growth phase. The cluster is home-grown and its history goes back three decades. It has survived losing its three anchor companies and weathered through the “technology bubble burst”.

The Vancouver region’s most important benefits with regards to the wireless industry lay in factor conditions. However, its differentiating characteristics are derived from the presence of related industries. The nature of demand, and the internal structure and dynamics pose challenges to this cluster. A survey conducted within this project shows that Vancouver companies participate in disjointed portions of the global wireless industry value chains and that the cluster does not have a strong core specialization or anchor companies. However, it has wireless activity concentrations that are located close to the periphery of the cluster, particularly near the intersections with the new media, enterprise software, and device and equipment manufacturing local clusters. The inter-firm exchange and collaboration within the cluster are very limited and remain to be developed.

The strategies and actions that aim at enhancing the Vancouver wireless firms’ competitive advantages focus on improving their internal structures and management processes, and nurturing collaboration, and shared values and goals.
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<th>Abbreviation</th>
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<tr>
<td>ICT</td>
<td>Information Telecommunication Technology</td>
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<td>LAN</td>
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<td>NAICS</td>
<td>North American Industry Classification Standard</td>
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<td>PAN</td>
<td>Personal Area Network</td>
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<td>PCS</td>
<td>Personal Communication System</td>
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<td>SAT</td>
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<td>Vancouver</td>
<td>Greater Vancouver Regional District</td>
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<td>WAN</td>
<td>Wide Area Network</td>
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<td>WLAN</td>
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<td>WinBC</td>
<td>Wireless Innovation Network of British Columbia</td>
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</tbody>
</table>
# TABLE OF CONTENTS

Approval ....................................................................................................................................... ii
Abstract ........................................................................................................................................ iii
Abbreviations ................................................................................................................................ iv
Table of Contents .......................................................................................................................... v
List of Tables ................................................................................................................................... vii
List of Figures ................................................................................................................................ viii

1 Introduction ............................................................................................................................... 1
   1.1 Project Context and Objectives .......................................................................................... 1
   1.2 Cluster Approach Theory Backgrounds and Applications .............................................. 2
      1.2.1 Cluster Approach Overview ....................................................................................... 2
      1.2.1.1 Nations Competitive Advantage and Clusters ....................................................... 2
      1.2.1.2 Cluster Diamond ................................................................................................... 3
      1.2.1.3 Cluster Approach Assessment ............................................................................. 4
   1.2.2 Cluster Approach Implications on Company Strategic Decisions .............................. 6
      1.2.2.1 Clusters and Competition ...................................................................................... 6
      1.2.2.2 Cluster Advantages to Companies ......................................................................... 6
      1.2.2.3 Cluster Approach as a Tool for Strategic Decisions ............................................ 7
   1.3 Project Methodology .......................................................................................................... 9
   1.4 Project Organization ........................................................................................................ 10

2 Wireless Telecommunication Industry ..................................................................................... 11
   2.1 Industry Definition ........................................................................................................... 11
   2.2 Industry Segmentation .................................................................................................... 12
   2.3 Value Chain .................................................................................................................... 14
   2.4 Industry Size, Growth, Prospects and Attractiveness ....................................................... 17
      2.4.1 Telecommunication Services ...................................................................................... 17
      2.4.2 Cellular Wireless Services ......................................................................................... 19
      2.4.3 Cellular Wireless Terminals ....................................................................................... 20
      2.4.4 Public Wireless LAN .................................................................................................. 20
      2.4.5 Wireless Telecommunication Equipment Concentration and Localization .......... 22
      2.4.6 Trends and Opportunities ......................................................................................... 25

3 Wireless Telecommunication Clusters Analysis .................................................................... 27
   3.1 United States .................................................................................................................. 27
      3.1.1 California ................................................................................................................... 28
      3.1.2 Bay Area Wireless Cluster ....................................................................................... 28
   3.2 Finland ............................................................................................................................ 30
      3.2.1 Helsinki Wireless Cluster ......................................................................................... 31
   3.3 Canada ............................................................................................................................. 33
      3.3.1 Ottawa ...................................................................................................................... 35
      3.3.2 Calgary ....................................................................................................................... 37

4 Vancouver Wireless Telecommunication Cluster .................................................................... 40
LIST OF TABLES

Table 1 - Cluster’s Dimensions and Firm Strategy................................................................. 9
Table 2 - World Cellular Phone Subscribers ........................................................................... 19
Table 3 - United States, Finland and Canada Mobile Phone Subscribers ............................ 20
Table 4 - Worldwide Number of Public WLAN ‘Hot’ Spot Locations by Type ................ 21
Table 5 - Worldwide Sales Predictions for Wireless Infrastructure Equipment ................. 23
Table 6 - Worldwide Sales of Mobile Terminals to End Users (2002-2003) ..................... 24
Table 7 - Top 5 Worldwide Wireless LAN Equipment Vendors by Unit Shipments (2002) .... 25
Table 8 - ICT Clusters in Canada ......................................................................................... 34
Table 9 - Vancouver Narrow Wireless Cluster Company Examples .................................. 43
Table 10 - Wireless Clusters Comparison Summary........................................................... 64
LIST OF FIGURES

Figure 1 - Porter Diamond: the Determinant of National Advantage................................................. 4
Figure 2 - Wireless Telecommunication Industry Tri-dimensional Segmentation............................ 14
Figure 3 - Wireless Industry Value Chain - Technological Dependencies ..................................... 15
Figure 4 - Wireless Industry Value Network.................................................................................... 16
Figure 5 - Wireless Industry Value Chains...................................................................................... 16
Figure 6 - Worldwide Growth of ICT Users .................................................................................... 17
Figure 7 - Worldwide Telecommunication Services Revenue Breakdown (1992-2002).................... 18
Figure 8 - Wireless Handsets Sale to End Users by Region............................................................. 21
Figure 9 - Forecast for the Global WLAN Market Growth Segmented by Product Category.......... 22
Figure 10 - Bay Area Wireless Cluster Diamond Analysis............................................................... 30
Figure 11 - Helsinki Wireless Cluster Diamond Analysis................................................................. 33
Figure 12 - Ottawa Wireless Cluster Diamond Analysis................................................................... 37
Figure 13 - Calgary Wireless Cluster Diamond Analysis................................................................. 39
Figure 14 - Vancouver Wireless Company Distribution by Ownership, Origin and Size................. 46
Figure 15 - Vancouver Wireless Company Concentration............................................................... 48
Figure 16 - Vancouver Wireless Activity Concentration................................................................. 50
Figure 17 - Vancouver Wireless Company Distributions................................................................. 51
Figure 18 - Vancouver Companies Positioning on the Wireless Industry Value Chains................ 53
Figure 19 - Vancouver Wireless Cluster Value Network.................................................................... 54
Figure 20 - Vancouver Wireless Industry Cluster Diamond Analysis Summary............................. 55
1 INTRODUCTION

The need for communication, mobility and overcoming the challenges of distance has stimulated technological advancement in the field of wireless communications. Today, wireless devices and solutions have infiltrated and transformed many aspects of corporate, community and individual activities across the globe. The wireless telecommunication industry in particular has enjoyed extraordinary growth during the last decade. In Vancouver, an expanding grouping of more than 150 companies is involved in various activities related to this expanding industry. This project intends to study the Vancouver wireless telecommunication industry cluster characteristics, evolutions and prospects.

This first chapter further defines the context of this project. It also introduces the industry clusters approach and provides a literature review about the topic. Then it describes the project’s overall methodology and organization.

1.1 Project Context and Objectives

The Vancouver area, in the context of this project, is synonymous to the metropolitan region know as the ‘Greater Vancouver Regional District’ in the province of British Columbia, Canada. This metropolitan area expands over 21 municipalities and includes two million residents (GVRD, 2003).

This project approaches the topic of the Vancouver wireless telecommunication industry cluster from different angles. It focuses on micro-level firm linkages and company strategies to analyze the development of the cluster and its association with supporting infrastructure. First, the project introduces and summarizes the theories and approaches related to industry cluster economic development. In particular, the hypothesis regarding strategies that firms adopt within their clusters is synthesized through a review of literature on the subject. Then, the project defines and examines the external global environment where the cluster participates, especially the size and attractiveness of the industry. These two aspects have important implications on new business formation and cluster growth. Also, the project aspires to provide better understanding of the cluster evolution, internal structure and dynamics. In addition, the Vancouver wireless cluster is compared to a selection of similar groupings in other geographical locations. This
examination reveals aspects of its strengths and weaknesses. Furthermore, the project uncovers some of the challenges and issues facing the cluster. Then, selected strategies and actions are proposed to enable individual companies in the cluster, or dependant on it, to gain advantages from the local environment in order to improve their competitiveness and sustain their growth. Finally, recommendations are formulated regarding cluster management as well as public policy approaches to enable companies to better compete globally and sustain their development.

1.2 Cluster Approach Theory Backgrounds and Applications

1.2.1 Cluster Approach Overview

1.2.1.1 Nations Competitive Advantage and Clusters

In the mid 1980s, Michael Porter introduced the concept of "competitive advantage" (Porter, 1998c) that brought company strategy to the forefront attention of both scholars and corporate executives. This concept dynamically links a firm strategy to the industry it chooses to participate in. In 1985, Porter extended the use of the "competitive advantage" concept from the micro-level of a firm to the macro-level of a region or a nation to compete globally (Porter, 1998b). The central piece of "competitive advantage of a nation" is the notion of industrial "cluster".

"A cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" (Porter, 2000, p. 17). The cluster includes linked industries and organisations, including suppliers, channels and customers, supporting industries and public institutions such as government agencies, universities and trade associations.

On the practical side, the Strategy and Competitiveness Cluster Mapping Project led by Michael Porter makes two important distinctions (Institute for Strategy and Competitiveness, 2003) that are very relevant to the discussion and analysis about clusters:

- **Traded vs. local clusters**: a "local cluster" is a grouping of "local industries" that are usually present in most geographic areas and primarily serve the local market; conversely a "traded cluster" is made of "traded industries" that are typically concentrated in specific geographic areas and sell to markets beyond their local region. In the rest of this document the term "cluster" is synonymous to "traded cluster".
Narrow vs. broad clusters: related specifically to traded clusters, a “narrow cluster” defines industries that are unique only to the cluster and can be considered as its core; while a “broad cluster” refers to industries that are not unique to the cluster. They may fall into and overlap with other traded clusters and are better thought of as supporting or peripheral industries.

On the surface, the cluster approach and the role of nations or regions seem to go against the ever-increasing globalization trends (Porter, 1998a). Indeed, the advancement in telecommunication technology and transportation has enabled companies on one hand to market their products globally and achieve economies of scale. On the other hand, it has enabled them to distribute their operations across the globe. Global companies are able to gain benefits from the local advantages of particular geographical areas. These advantages could take the form of low cost or skilled labour, proximity to markets or suppliers of raw materials, and taxation and other policy incentives. However, Porter argues, “national differences in character and culture, far from being threatened by global competition, prove integral to success in it” (Porter 1998b, p. 30).

1.2.1.2 Cluster Diamond

One of the most important aspects of the cluster approach, introduced by Porter, is the cluster “diamond” representing the four “determinants of national advantage” that shape the evolution of a particular industry cluster (Porter, 1998b, pp. 71-124). The four determinants are:

- **Factor conditions**, which include human resources, physical resources, natural resources, knowledge resources, capital resources and various aspects of infrastructure.
- **Demand conditions**, which involve three characteristics: home demand structure, sophistication of domestic buyers and anticipatory buyer needs.
- **Related and supporting industries**, which emphasise the linkage among industries along the value chain as a way to create both synergies and additional competitiveness.
- **Firm strategy, structure, and rivalry**, which reflect the way that firms are created, organized and managed, and the nature of local rivalry among firms.

These four determinants continuously and dynamically interact and influence each other and thus their representation is as a diamond with arrows between the different nodes, as shown in Figure 1. Two more aspects also have great influence on the outcome of a cluster:
Chance events, which are created by circumstances outside the control of the cluster’s stakeholders, have been in many instances crucial in shaping industry success. These events include: inventions, revolutionary technologies, entrepreneurship and changes in environment.

Government role is also recognized to have a significant influence over the determinants and the competitive environment.

Besides providing a framework for understanding a regional and national economy and organizing economic development thinking, the “national advantage diamond” is a very powerful tool for analyzing and gaining valuable insights about the internal dynamics and the potential of existing industry clusters.

1.2.1.3 Cluster Approach Assessment

One of the most important aspects of the cluster approach is that it provides a framework for industrialization policies departing from traditional defensive and offensive policies that are often unsuitable for the modern economic climate (Jacobs & De Man, 1996). On the one hand, defensive policies perpetrate the practice of ‘backing losers’ in their courtyard by insisting on raising protectionism barriers to protect weak industries from foreign competition. On the other
hand, defensive policies attempt to ‘pick the winners’ by directing the economic sectors toward selected industries thought to have high growth potential. Both policies have been demonstrated to be very restrictive and lead to poor results on the long term. Cluster based policies, on the contrary, adhere to ‘backing the winners’. They reinforce existing strengths of the economy by improving the linkage between firms, networking opportunities and knowledge sharing possibilities.

In recent years, the “cluster approach” has gained a lot of ground around the world among academics (Porter, 1998a; Porter, 1998b; Martin & Sunley, 2001; Langford, 2002; Langford 2004), government agencies (Industry Canada, 2004a and 2004b; Leppävuori, 2002; Lord Sainsbury, 1999; Frighetto, 2001; Lundequest & Power, 2002; Santos, 2002), local authorities and organizations involved in local and regional development (Deloitte, 2004; Vancouver Economic Development Commission, 2002; Paija 2000; Tukiainen, 2002), and industry associations (PriceWaterhouseCoppers, 2004; RTA & OMC, 2002; TIEKE, 2003).

Furthermore, many organizations around the world are attempting to scan and map clusters. Michael Porter is leading a group called the Strategy and Competitiveness Cluster Mapping Project that exhaustively locates and compares clusters across the United States (Institute for Strategy and Competitiveness, 2003). Another example is a group from Sweden called the Ivory Tower that studies clusters worldwide. This group estimates that in 2003 there are more than 500 cluster initiatives around the world (Sölvell et al., 2003, p. 10). These initiatives tend to focus on large-scale economic sectors that may combine multiple industries.

Still, Porter’s cluster approach has been the target of criticism. One of the most important shortcomings of the approach has been its lack of specificity in terms of delineating the boundaries of a cluster. In fact, the concept has been indiscriminately used for different types, size, processes and geographical scales of economic localization. This “theoretical confusion and conceptual fuzziness” poses problems in systematically and directly identifying clusters as opposed to concentrations of activities that may not be linked (Martin & Sunley, 2002).

Porter’s quantitative approach for determining the presence of clusters also suffers from the limitation that it doesn’t show whether interrelationships between firms in a cluster really exit. Thus a distinction is made between clusters and networks. “Clusters are broad sets of industries in which not all firms are cooperating with each other. Those firms in cluster which do interact form networks within the cluster, or between clusters” (Jacobs & De Man, 1996, p. 428).
1.2.2 Cluster Approach Implications on Company Strategic Decisions

1.2.2.1 Clusters and Competition

The major benefit of a cluster is that it ultimately creates "a system of interconnected firms and institutions whose whole is more than the sum of its parts" (Porter, 2000, p. 21). The cluster in its entirety benefits by leveraging the local demand advantages which "can reveal segments of the market where firms can differentiate themselves." In this regard "the quality of local demand matters far more than does its size" (ibid). It also reaps the benefits by affecting the competition in three general aspects:

- Increase in the current productivity of member firms or industries,
- Increase in the capacity of cluster participants for innovation and productivity growth,
- Stimulation of new business formation that supports innovation and expands the cluster.

These aspects emphasize the fact that "many cluster advantages rest on external economies or spillovers across firms, industries, and institutions of various sorts" (ibid).

1.2.2.2 Cluster Advantages to Companies

After studying the behaviour of companies that were successful in developing sustainable competitive advantage, Michel Porter identifies various actions that these companies adopt to take full advantage of their presence in a cluster (Porter, 1998b, pp. 578-84).

- Innovation: a company should make the most use of home base innovation opportunities and improve its own flexibility to pursue them. Innovation is not restricted to products; it also incorporates business processes, marketing approaches, management, strategy etc.
- System view of the value chain: advantage may be gained through better configuration of the value chain that a company is involved in. Companies should help the extension and strengthening of the cluster by encouraging the formation of suppliers, improving the sophistication of customers or stimulating entry to related industries (Porter, 1998b, p. 580).
- Continuous strategy adjustment: Sustaining a firm's own competitive advantage requires continuous adaptation and improving of its strategy. A firm ought to "expose itself to external pressures and stimuli that motivate and guide the need to act" (Porter, 1998b, pp. 581-2). Change rarely comes from inside the company; instead agents from the external
environment often trigger it. Thus, the company could gain an advantage by positioning itself in such a way that these “outsider agents of change” are within the home base.

- **Improving the source of own competitive advantage:** Companies should resist the urge to lobby to suppress the sources of local pressures from factor suppliers or government. Instead they would better consider these forces as opportunities to initiate change in order to improve their competitiveness over time.

- **Global approach:** Firms should pursue global strategies as much as possible. By doing so, they would both offset some of the disadvantages of the home base and reach bigger markets. The additional financial gains from global strategies allow these companies to be in better positions to re-invest in improving and further strengthening the home base cluster’s advantageous features or eliminating its weaknesses. Thus global expansion is a self-reinforcing mechanism for the company.

### 1.2.2.3 Cluster Approach as a Tool for Strategic Decisions

Porter identified multiple strategies that companies ought to adopt depending on the nature of the cluster they belong to (Porter, 1998b, pp. 599-601).

- **Analysing international competitors:** The diamond analysis is used for scanning competitors’ home bases. This investigation reveals some of these competitors’ inherited advantages, disadvantages and goals depending on the factors and structure they rely on. Eventually this information enables companies to predict competitors’ likely behaviours and future moves.

- **Industry and location choice:** “a firm or individual has the best odds of succeeding in innovation, or in creating a new business, where the national diamond provides the best environment” (Porter, 1998b, p. 602).

- **Strategy choice:** The choice of basic strategy is tied to the nature and strength of particular determinants within the diamond (Porter, 1998b, p. 602).
  
  - **Cost-oriented strategies** are more suitable when there are distinctive advantages in factor costs, the size of home demand, and the conditions that favour large-scale plant investments.
  
  - **Differentiation strategies** tend to rely more on specialized human resources, sophisticated local buyers, and world-class local supplier industries.
  
  - **Focus strategies** entail the presence of unusual demand in particular segments or on factor conditions or supplier access that benefit competing in a particular product range.
**Penetrating foreign markets**: A company should choose to compete globally on segments where its home base provides advantages but which are modest or are emerging segments in foreign nations. In these cases, local companies or international rivals based in other nations will often have turned their attention elsewhere and be unprepared to compete.

**Diversification**: For mature companies the choice of new industries for diversification should be based on those where a favourable national diamond is present or can be created. “Diversification proposals should be screened for the attractiveness of the home base” (Porter, 1998b, p. 606).

Jacobs and De Man (1996) take a pragmatic perspective on clusters. They suggest that clusters may have multiple dimensions and propose a menu approach for picking firm strategies specific to each dimension (Table 1). They argue that “by making the dimensions of clustering explicit, we provide a basis upon which tailor-made policies can be developed. Consequently, the effectiveness of policies and strategies will be enhanced” (Jacobs & De Man, 1996, p. 425).

The cluster approach has multiple level applications in economy and strategy. It has gained such worldwide authority in macro-economical analysis and industrial policy design that it is quasi-present in many government policies. It is starting to appear as a public policy panacea that every government is trying to adopt (Martin & Sunley, 2001). A second area of application concerns managing established clusters. The cluster approach put forward a pragmatic and simple framework for studying, analysing and understanding the dynamics of local clusters. The cluster approach has a third important application in shaping firm strategy. By being grounded in the competitive advantage theory, the cluster approach helps companies formulate appropriate strategies to take advantage of their presence or proximity to industrial clusters.

Unfortunately, the last application does not get as much attention as the two others either in academic or business circles even though it is the firm that is on the front line of competition and that ultimately produces value. More consideration needs to be directed to turning the inherent advantages of an identified cluster into tangible benefits by helping companies take appropriate actions.

The Vancouver region is home to various industry clusters and thousands of companies. The wireless cluster in Vancouver is an important part of the local economy. It has been continuously growing and competing globally in a dynamic industry. Thus, it is important to analyze it and compare it with others to determine how it should position itself and be managed. Furthermore, it is very beneficial to identify appropriate strategies and actions that allow the companies belonging to this cluster to perform better.
<table>
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<th>Dimension</th>
<th>Strategy towards own cluster</th>
<th>Strategy towards other clusters</th>
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| Geographical scope | Behave positively in own regional networks  
Take part in relevant programs                                                                 | Tap into foreign clusters  
Take part in relevant programs                                                                 |
| Horizontal       | Strike a balance between competition and cooperation  
Support sector initiatives in education, environmental and quality policies, internationalization and market development | Learn from foreign competitors  
International sector initiatives                                                                 |
| Vertical         | Organize the user-producer-supplier  
Exchange staff  
Co-location in design and production                                                           | Locate activities near advanced clients and suppliers  
Forge relations with clients in other countries in order to upgrade products                 |
| Lateral          |                                                                                             | Establish new combinations with (elements of) other clusters                                    |
| Focal            | Strengthen relation with knowledge infrastructure in own environment                         | Forge relations with top foreign institutes                                                     |
| Technological    | Is the basis for choosing between developing core competencies individually or in cooperation |                                                                                                 |
| Quality of network | Strengthen partners' knowledge  
Enhance international orientation of cluster  
Introduce of new coordination mechanisms between firms                                             |                                                                                                 |

Table 1 - Cluster’s Dimensions and Firm Strategy

1.3 Project Methodology

This project combines data and information from various sources, and quantitative and qualitative analyses to study the various aspects of the Vancouver wireless industry cluster. The project starts with examining the wireless industry in its wider and global contexts and its structure based on the synthesis of the findings of various academic publications and industry trade studies. Following this review, the project proposes appropriate frameworks for industry segmentation and value chain in order to investigate the Vancouver wireless industry’s structure and dynamics. The project then summarizes key numerical figures about the size, growth,

1 Adapted from Jacobs & De Man (1996, p. 434).
prospects and trends of the global wireless industry. These figures are synthesized from secondary research sources, particularly reports and press released from trade associations, and reputable market research and consulting firms. The purpose of this macro-analysis is to develop an appreciation of the industry size and identify its degree of attractiveness to incumbent companies and potential new entrants. These two features have important implications on the development of Vancouver’s local industry.

A study of selected wireless clusters is carried out using the Porter cluster diamond framework. The information for the investigation is obtained from various studies that examine these specific clusters. The results of these qualitative analyses serve as a comparison against which to analyse and understand the Vancouver wireless cluster.

Next, the Vancouver wireless industry is analyzed in detail. This examination entails a synthesis of previous studies’ findings, a survey to collect selected data on all the firms belonging to the Vancouver wireless narrow cluster, and a qualitative analysis based on interviews of representatives from the industry and reviews of corporate and industry publications. These analyses are instrumental in uncovering the most important challenges and issues facing the local industry. The synthesis of the results of the various investigation and analyses reveals the structure and dynamics of the local industry. It also supports the elaboration of strategy recommendations to various participants in the cluster.

1.4 Project Organization

This project is organized into five chapters. Chapter 2 analyzes the telecommunication wireless industry in general. It defines the industry and proposes a segmentation using multiple dimensions. It also proposes an appropriate value chain framework to examine competitiveness and rivalry in a wireless cluster. Additionally, it synthesizes various statistical data to provide insights about industry size, structure, growth patterns and trends. Chapter 3 examines four separate metropolitan wireless telecommunication clusters using the diamond cluster approach. Chapter 4 examines in detail various aspects of the Vancouver wireless cluster, including historical development, structure, strengths, weaknesses, and value chain. The chapter also describes three sample companies within the cluster. Chapter 5 synthesize strategy recommendations for the cluster individual firms and for the management of the cluster itself. Finally, a section at the end lists the references used for this project.
2 WIRELESS TELECOMMUNICATION INDUSTRY

The wireless telecommunication industry is one of the main branches of the Information and Communication Technology (ICT) economic sector. Wireless technology is not new; in fact it dates back to the beginning of the 20th century with the invention of radio broadcasting. However, the tremendous expansion of this industry only started in the 1980s with the use of wireless technologies for personal communication systems (PCS). Since then, wireless telecommunication has been among the fastest growing industries and is expected to continue expanding at a considerable rate. The International Telecommunication Union for example, forecasted that in 2003, wireless telecommunication services revenues would amount to approximately US$ 410 billions representing 36% of the total worldwide telecommunication revenues (International Telecommunication Union, 2001).

This chapter defines and describes both the general and global contexts of wireless telecommunication industry. It synthesizes qualitative and quantitative data to get an appreciation of the size of this global industry, and its growth patterns and prospects. Additionally, it proposes frameworks to analyze various aspects of the industry such as enabling technologies, interaction between the participants and industry value chain. This information is fundamental for the rest of this project because most of the Vancouver wireless companies are involved in traded sub-industries and compete on a global scale.

2.1 Industry Definition

Clearly defining the perimeters of the wireless telecommunication industry is challenging. The same challenge is facing the ICT sector in general. Traditional industry classifications, such as NAICS2, generally focus on the products or services themselves to define the industry. In many instances, this classification fails to capture important aspects of competition between firms such as those due to product substitutions or complementarities. For this reason, the definition of an industry should be broadened beyond the nature of a product to describe the function it accomplishes. This definition would inevitably group together firms

2 NAICS: North American Industry Classification System
usually classified under different standard economical industries, segments and even sectors. In the context of this project:

*Wireless telecommunication industry encompasses firms primarily engaged in producing goods and services, or supplying technologies intended to fulfill or enable the function of processing, transmitting and receiving information that move electro-magnetically through the airwaves.*

### 2.2 Industry Segmentation

Industry segmentation consists of dividing an industry into stand-alone subgroups or pockets in order to understand and analyze the scope of competition within each subgroup. Industry segmentation builds on market segmentation, which focuses almost exclusively on customer type, to add other dimensions for subdivision. Additionally, industry segments “frequently involve differing buyer value chains and/or the value chain a firm requires to serve them well” (Porter, 1998c, p. 231). Porter (1998c) suggests four variables to segment industries: product variety, buyer type, channel and geographic buyer location.

Channel and geographical buyer location are not important factors for differentiating wireless telecommunication sub-categories. This is due to two facts: that channels are generally part of the industry and that globalization and standardization have rendered buyer location of little impact on firms’ general strategies. The basic enabling technologies used, however, create distinctive divisions within this industry.

Therefore in this project, the wireless telecommunication industry is segmented based on three dimensions: product variety, key technology and customer type. Similar to the classification adopted by the Athena Institute (2002), each one of these dimensions is divided into several subcategories. This chosen method of segmentation is used as the base for sketching an industry value chain and value network, assessing the strength of the Vancouver wireless cluster and analysing the patterns of specialization and cooperation within the cluster.

The wireless telecommunication industry tri-dimensional segmentation consists of the following:

1. **Product or Service Variety:**

---

3 For example Statistics Canada identifies the Information and Communication Technology (ICT) Sector as a "special aggregation" of NAICS industries. This sector is defined as comprising "industries primarily engaged in producing goods or services, or supplying technologies, used to process, transmit or receive information". The “special aggregation” consists of 25 NAICS industries from four different economical sectors (Statistics Canada, 2002).
a- **Equipment**, which consists of both infrastructure (e.g. cellular base stations) and end user products (e.g. wireless phone, pager). Components are also part of this category.

b- **Transport** providing national or regional networks for carrying data and voice.

c- **Software** used both for infrastructure (e.g. operating or billing systems) and by end users (e.g. web browser on wireless hand held devices)

d- **Services** for both infrastructure (e.g. installation) and end user (e.g. online payment). Content for users is also included in this section (e.g. stock market quotes)

2. **Key technologies:**

   a- **Cellular/PCS wireless**, which replaces phone lines. Two examples are Telus Mobility or Fido services.

   b- **Fixed wireless**, which replaces the "last-mile" copper or fiber cables connecting homes, businesses and neighborhoods to the central station. For example: fSONA laser beams

   c- **Wireless local area networks (WLANs)**, which replace the cables connecting Ethernet LANs. An example is WiFi (802.11b).

   d- **Personal area networks (PANs)**, which replace the cables connecting electronic devices (PCs to printers, for example). Example: Bluetooth.

   e- **Satellite**, which enables global reach and coverage.

3. **Buyer types:**

   f- **Carrier-class** products and services are sold to the large wireless providers such as Bell Mobility. Companies in this category include giants such as Nokia, Ericsson and Motorola.

   g- **Enterprise-class** products and services are sold to large organizations for their internal use. IBM, Oracle, DataCritical, and others are in this space.

   h- **Consumer-class** products and services are sold to individual end users. Handsets are an example of a consumer-class product. Many carriers offer consumer-class services, such as pre-paid wireless subscriptions or mobile message services (MMS).

Thus the wireless industry segmentation is better represented as three-dimensional parallelepiped as shown Figure 2.
2.3 Value Chain

Porter introduced value chain analysis (1998c) in the mid 1980s to conceptualize and analyze both the internal dynamics of an industry as well as its external interaction with other industries in the course of creating, transforming and providing products and services to customers. There are different ways to map an industry value chain. Figure 3 illustrates one representation of the interaction within the industry that reflects the technological dependency value chain. This representation is similar to one adopted by WinBC (2004a) for example.

This value chain representation has the merit of being simple and linear. It was valid in the 1980s when large wireless phone carriers dominated the industry. The carriers used to simultaneously provide the network infrastructure, the user equipment, the communication access service and often some content. However, the industry has evolved to become more fragmented and is now dominated by companies with narrow specializations. Additionally, specialized value chains around specific sub-markets or product groups have emerged. Each one of these chains has a different process, dynamics and economic relationships. More complex mapping has been used to represent the intricate relationships between industry segments and the emergence of fields of specialization. Various authors and organizations have proposed new models such as a wireless value chain (Leppävuori, 2002, p. 2); and value chain relationship...
(Constance & Grower, 2001, p. 19). Figure 4 illustrates a value chain mapping that is derived from a Durlacher & Eqvitec (2001, p.23) report about mobile industry. This representation uses a network value model that coherently translates the complexities of the interactions between various industry sub-segments.

![Wireless Industry Value Chain - Technological Dependencies](image)

**Figure 3 - Wireless Industry Value Chain - Technological Dependencies**

This project proposes a new representation of the wireless telecommunication industry value chain. The proposed model is congruent with the industry segmentation described earlier. However, it distinguishes multiple sub-value chains within this industry, depending on the end user needs it fulfills. From the outset the wireless industry provides four types of output:

1. **Access points** to a network for example public telecommunication system connection;
2. **End-user devices and terminals** to be able to communicate, such as cell phone, wireless PDA, a satellite modem or blue-tooth device, to communicate with other devices, users, and systems;
3. **Internal connectivity** such as linking portable scanning devices to a central database in a large department or grocery store;
4. **Content** for example transmitting real-time NHL games scores to a wireless PDA.

These outputs are complementary but conceptually separate and quasi-independent industry value chains produce them. The proposed model is represented in Figure 5.
Figure 4 - Wireless Industry Value Network

Figure 5 - Wireless Industry Value Chains
2.4 Industry Size, Growth, Prospects and Attractiveness

Determining the total size of the overall wireless telecommunication industry and its sub-sectors is beyond the scope of this study because of its complexity and extensiveness. Instead, this section provides numerical data about selected wireless industry sub-segments to develop an appreciation of the total wireless industry size, past evolution and growth potential. The information provided is based on secondary data obtained from various sources. The following areas are examined because of their relevance to the Vancouver wireless industry:

- Telecommunication services
- Wireless subscribers
- Wireless handset sales
- Public wireless LAN (WLAN)
- Wireless data devices

2.4.1 Telecommunication Services

In terms of number of subscribers, wireless telephone has already surpassed fixed phone and continues to grow at an enormous rate superior to all the other sectors, as shown in Figure 6. The growth patterns of cellular usage suggest that wireless services revenues would continue to grow and inevitably surpass those of fixed telephone services by 2005 or 2006.

\[\text{Figure 6 - Worldwide Growth of ICT Users}\]

\[^{4}\text{Data source: International Telecommunication Union ITU (2001). Refer to Appendix 1 for further details.}\]
Between 1992 and 2002 global annual revenues from telecommunication services had more than doubled and increased from US$ 491 billions to US$1,084 billions. Figure 7 reveals that this extensive growth is primarily due to the expansion of wireless telecommunication. Wireless telecommunication revenues progressed from US$ 26 billions (7% of total telecom) to 364 billions (34% of total telecom). During the same period, fixed telephone service only increased by 32% (International Telecommunication Union ITU, 2001).

Figure 7 - Worldwide Telecommunication Services Revenue Breakdown (1992-2002)

\(^5\) Data source: Ibid
2.4.2 Cellular Wireless Services

According to recent statistics summarized in Table 2, 1,340 million people worldwide subscribed to cellular phone services in 2003. In other terms, one of every five people worldwide owns a wireless phone today. During the past five years the wireless services have grown at an average of 33% every year. Very few industries of this size have achieved such a performance in such short period of time.

Table 2 reveals an uneven spread of wireless usage across the world based on the distribution of wireless subscribers by continents. On the one hand, considering the trends in globalization and normalization of living standards across the world’s nations, the current inequalities in wireless distribution would sustain the high-rate growth of wireless communication sector expansion for the upcoming years, especially in developing countries. This translates into continuing high demand for wireless telecommunication equipment and network infrastructure, as well as user terminals to access the service. On the other hand, the high penetration rate in developing countries creates high competition because of the saturation of the markets. Consequently this situation would drive up the need for innovation to improve the wireless communication infrastructure efficiencies. In addition, there would be a rising need to develop new products and services to ensure differentiation and increase revenues from exiting customers.

<table>
<thead>
<tr>
<th>Continent</th>
<th>1998</th>
<th>2003</th>
<th>CAGR(^6) (%) 1998-03</th>
<th>Per 100 inhabitants (2003)</th>
<th>As % of total telephone subscribers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>4,156</td>
<td>50,803</td>
<td>65</td>
<td>6.2</td>
<td>67.3</td>
</tr>
<tr>
<td>Americas</td>
<td>95,066</td>
<td>288,220</td>
<td>25</td>
<td>33.8</td>
<td>49.8</td>
</tr>
<tr>
<td>Asia</td>
<td>108,320</td>
<td>543,153</td>
<td>38</td>
<td>15.0</td>
<td>52.4</td>
</tr>
<tr>
<td>Europe</td>
<td>104,382</td>
<td>441,235</td>
<td>33</td>
<td>55.4</td>
<td>57.5</td>
</tr>
<tr>
<td>Oceania</td>
<td>5,748</td>
<td>17,256</td>
<td>24</td>
<td>54.5</td>
<td>57.2</td>
</tr>
<tr>
<td>World</td>
<td>317,674</td>
<td>1,340,667</td>
<td>33</td>
<td>21.9</td>
<td>53.9</td>
</tr>
</tbody>
</table>

*Table 2 - World Cellular Phone Subscribers\(^7\)*

---

\(^6\)CAGR: Compound Annual Growth Rate

\(^7\)Data source: International Telecommunication Union (2004)
Country specific data for the United States, Finland and Canada are summarized in Table 3. Wireless telecommunication industry clusters in these specific countries are discussed in the next chapter.

<table>
<thead>
<tr>
<th>Continent</th>
<th>1998</th>
<th>2003</th>
<th>CAGR (%) 1998-03</th>
<th>Per 100 inhabitants 2003</th>
<th>As % of total telephone subscribers</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>69,209</td>
<td>158,722</td>
<td>18</td>
<td>54.3</td>
<td>46.6</td>
</tr>
<tr>
<td>Finland</td>
<td>2,846</td>
<td>4,700</td>
<td>10</td>
<td>90.0</td>
<td>64.8</td>
</tr>
<tr>
<td>Canada</td>
<td>5,365</td>
<td>13,221</td>
<td>20</td>
<td>41.7</td>
<td>39.9</td>
</tr>
</tbody>
</table>

*Table 3 - United States, Finland and Canada Mobile Phone Subscribers*

2.4.3 **Cellular Wireless Terminals**

Sales of wireless cell phones have similar growth patterns to those related to the number of wireless phone subscribers and service revenues. Figure 8 shows statistics related to worldwide cell phone sales by region. The bulk of the sales are in the Asia-Pacific region, North America and Western Europe. This year estimates predict that about half a million cellular phones will be sold across the world.

2.4.4 **Public Wireless LAN**

Wireless data communication is a sector that has lagged behind wireless voice applications. However, this trend has been changing in recent years. Enabling employee mobility has been the main driver behind this growth. An interesting aspect about this sector is a shift toward providing this type of access service through private non-telecommunication companies. An important component of this sector consists of 'public wireless LAN' or 'public WLAN'. This sub-sector has shown signs of tremendous growth in the past two years. Hotels, restaurants and communities have been the main providers of this access service, instead of traditional telecommunication companies. More than 70,000 public WLAN enabled, or 'hot', spots have been enumerated in 2003 as shown in Table 4. This number is expected to more than double by 2005.

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8 Data source: Ibid
The expansion of public WLAN access has also generated a ripple effect expanding to other sub-sectors such as enterprise infrastructure, user terminals, enabling application and service delivery. As it was the case for cellular phone networks, substantial growth is predicted for these related fields (Figure 9).

9 Data source: Gartner Dataquest (2003a)

10 Data source: Gartner Dataquest (2003b)
2.4.5 Wireless Telecommunication Equipment Concentration and Localization

On the international scene a few countries stand out in terms of their leadership, positioning and influence in the wireless telecommunication industry. The wireless activities are regionally concentrated in a small number of areas. Some the most important spots are as follows:

- **The United States** is undeniably occupying the most prominent position in the worldwide wireless telecommunication industry. It was one of the first countries to deregulate telecommunication, which initiated the information revolution across the world. The United States continues to lead the world in innovation and entrepreneurship.

- The Scandinavian countries were able to fundamentally transform their societies and economies from being resource-based to become information based. They have set a benchmark for successful public policy implementation and became the stars of the 1980s and 1990s in terms of competitiveness. This region emerged as a major player in the wireless telecommunication industry with two major companies: Nokia and Ericsson.

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11 Data source: Krebs (2000, p.2)
• Japan and Korea have distinguished themselves in this early part of the 21st century by taking the lead in deploying the most advanced wireless telecommunication infrastructure (3G or 3rd generation wireless). They have also significantly improved their research and development capabilities and resources.

• In terms of size, growth and future prospects, China stands at the forefront of the world scene by managing the deployment of the world’s largest wireless telecommunication networks. These deployments have been responsible for numerous industrial activities and firms’ creations within China.

Cellular wireless networks and terminal manufacturing industries tend to be global and geographically concentrated. The leading wireless infrastructure equipment vendors are Alcatel, Ericsson, Motorola, Lucent, Nokia, Nortel, Siemens and Samsung. Most of these players also develop and supply consumer handsets. Table 5 provides a forecast for this industry segment demand based on information provided by a leading market research firm. This table shows sustained growth over the next five years.

<table>
<thead>
<tr>
<th>Year</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>25,500</td>
<td>25,700</td>
<td>27,000</td>
<td>30,500</td>
<td>32,700</td>
<td>34,800</td>
</tr>
</tbody>
</table>

*Table 5 - Worldwide Sales Predictions for Wireless Infrastructure Equipment*

Cell phone vendors market their products across the world in spite of country and regional differences in communication standards. All the top players develop international brands and adopt global strategies. The Finnish based firm Nokia dominates the industry with a 35% market share. The second largest vendor is the US based Motorola with 15% of the market, which is less than half the share of the leader. Other major players in this industry include: the Korean based Samsung, the German Siemens, the Swedish-Japanese joint-venture Sony/Ericsson, and the Korean LG. The top six cell phone vendors are responsible for 80% of handset sales worldwide, indicating a high concentration of this sector of the industry. Table 6 lists all the major wireless handset vendors and their market share.

---

12 In US$ million

13 Data source: Dell’Oro Group (2004)
In contrast to the PCS industry, the WLAN equipment industry seems fragmented. Indeed, Table 7 shows that the market leader, Linksys, controls only a 15% market share. Furthermore, nearly half of the market share is distributed among a large number of smaller companies. Currently WLAN is highly concentrated in North America and Europe but it is expected to spread across the world.

<table>
<thead>
<tr>
<th>Company</th>
<th>2003 Sales(^1^4)</th>
<th>2003 Market Share (%)</th>
<th>2002 Sales</th>
<th>2002 Market Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nokia</td>
<td>180,672</td>
<td>34.70%</td>
<td>151,421</td>
<td>35.10%</td>
</tr>
<tr>
<td>Motorola</td>
<td>75,177</td>
<td>14.50%</td>
<td>72,852</td>
<td>16.90%</td>
</tr>
<tr>
<td>Samsung</td>
<td>54,475</td>
<td>10.50%</td>
<td>41,684</td>
<td>9.70%</td>
</tr>
<tr>
<td>Siemens</td>
<td>43,754</td>
<td>8.40%</td>
<td>34,618</td>
<td>8.00%</td>
</tr>
<tr>
<td>Sony/Ericsson</td>
<td>26,686</td>
<td>5.10%</td>
<td>23,112</td>
<td>5.40%</td>
</tr>
<tr>
<td>LG</td>
<td>26,213</td>
<td>5.00%</td>
<td>13,797</td>
<td>3.20%</td>
</tr>
<tr>
<td>Panasonic</td>
<td>16,809</td>
<td>3.20%</td>
<td>10,766</td>
<td>2.50%</td>
</tr>
<tr>
<td>NEC</td>
<td>13,484</td>
<td>2.60%</td>
<td>8,085</td>
<td>1.90%</td>
</tr>
<tr>
<td>Alcatel</td>
<td>7,246</td>
<td>1.40%</td>
<td>11,889</td>
<td>2.80%</td>
</tr>
<tr>
<td>Sagem</td>
<td>6,241</td>
<td>1.20%</td>
<td>4,743</td>
<td>1.10%</td>
</tr>
<tr>
<td>Others</td>
<td>69,228</td>
<td>13.30%</td>
<td>58,658</td>
<td>13.60%</td>
</tr>
<tr>
<td><strong>Total Market</strong></td>
<td><strong>519,988</strong></td>
<td><strong>100%</strong></td>
<td><strong>431,631</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Table 6 - Worldwide Sales of Mobile Terminals to End Users (2002-2003)\(^1^5\)

\(^1^4\) In thousand of units

\(^1^5\) Data source: Gartner Dataquest (2004)
2.4.6 Trends and Opportunities

The data presented in this chapter suggest the following trend about the global wireless telecommunication industry:

- The wireless industry overall will grow.
- Market concentration in the wireless industry will change (especially in developing countries).
- Wireless related service and application market will grow.
- The user terminal manufacturers will continue to innovate and add more functionality and features into handsets.
- Deployment of wireless enterprise solutions will be one of the highest growth areas.

In congruence with these trends, Nokia, one of the industry leaders for example, predicts that the industry “is moving rapidly into a new phase of advanced features and services. There are three key industry drivers taking us there: applications on the move, increasing role of software based on open compatible solutions, explosion of new innovative products” (Nokia, 2003).

From a technological point of view, wireless data and voice telecommunication conversion are driving the growth of the industry. The demand for Internet and mobility to improve the efficiency and effectiveness of the workforce is continuously increasing. This trend is already apparent in the current amalgamation into a single device of a cell phone and PDA

\[ \text{Table 7 - Top 5 Worldwide Wireless LAN Equipment Vendors by Unit Shipments (2002)}^{16} \]

<table>
<thead>
<tr>
<th>Company</th>
<th>2002 Shipments</th>
<th>2002 Market Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linksys</td>
<td>2,860</td>
<td>14.6</td>
</tr>
<tr>
<td>D-Link</td>
<td>1,881</td>
<td>9.6</td>
</tr>
<tr>
<td>Buffalo Technology</td>
<td>1,857</td>
<td>9.5</td>
</tr>
<tr>
<td>Symbol Technologies</td>
<td>1,762</td>
<td>9.0</td>
</tr>
<tr>
<td>Proxim</td>
<td>1,741</td>
<td>8.9</td>
</tr>
<tr>
<td>Others</td>
<td>9,495</td>
<td>48.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19,598</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

\[ ^{16} \text{Data source: Ibid} \]
(personal digital assistant). Another trend is that handset software platforms will play an ever-increasing role in wireless devices. As an example, the research firm ABI forecasts that about 150 million Smartphones\textsuperscript{17} will be sold in 2008 (ABI Research, 2004). A further trend is the ability of the same device to be able to use multiple radio access technologies to completely fulfill the end-user’s needs. For example, the same wireless PDA would communicate inside an enterprise through the WLAN using a Wi-Fi interface; and would switch automatically to use the public GSM network while outside the reach of the WLAN.

New areas for application of wireless technology continue to emerge. For example, radio frequency identification (RFID), which is a technology for enterprise asset tracking which uses wireless technology, is poised for tremendous growth. The Yankee Group, a research company, estimates that “during the next three years, manufacturers will spend approximately $2 billion on ePC RFID\textsuperscript{18} tags and $1 billion to $3 billion on infrastructure. The largest portion of infrastructure spending will be allocated to consulting and systems integration” (Yankee Group, 2004).

In summary, the global wireless telecommunication industry is expected to continue to grow. New applications, especially those destined for enterprise, are becoming major drivers, enabling the industry to expand considerably. These new applications are changing the industry landscape. By relying on disruptive technologies they also provide opportunities for new firms and nations possessing relevant inherent strengths to emerge and perhaps move to leadership roles in the industry.

\textsuperscript{17} A Smartphone is a handset which is an all-in-one device that offers the flexibility and facility of a handheld computer (PDA) with the communications ability of a mobile phone.

\textsuperscript{18} The Electronic Product Code (ePC) is a new product numbering standard under development by the Uniform Code Council that can be used to detect, track, and control a variety of items using RFID (Radio Frequency IDentification) technology.
3 WIRELESS TELECOMMUNICATION CLUSTERS

ANALYSIS

Wireless telecommunication companies, especially those involved in product development and design, usually exist in clusters because they require people with industry-specialized skills and experience in technologies such as radio wave propagation, analog design, signal conditioning, telecommunication standards, among others. The grouping of multiple companies in a geographical area creates the conditions for the development of the appropriate infrastructure to support them. It also creates the establishment of relevant academic specialization and the formation of related research and innovation environments. In this section four metropolitan wireless telecommunication clusters are explored: Helsinki (Finland), The Bay Area (US), Ottawa (Canada) and Calgary (Canada). These clusters are analysed to gain useful insights and appreciation about their dynamics and strengths, and most importantly the conditions that lead to the development of these strengths. In a later part of the study of the characteristics of these clusters enable comparison with the Vancouver wireless cluster.

The choice of these four metropolitan clusters in particular was based on the variety they present in terms of size, strengths, stages of development and conditions leading to their emergence.

3.1 United States

The United States is the world predominant nation in the wireless sector. The penetration of cell phones is high but it is lower than in many other developed countries. The country still relies on fixed telephones as the fundamental means of distance communication (Table 3). However, the defence industry, in addition to enterprise networks, is creating an unparalleled demand for wireless products, solutions and services. In the United States wireless telecommunication activities are concentrated in very specific areas and regions. The five largest regional wireless clusters in terms of number of firms are located in California, with 2,000 companies, Texas with 1100, Florida with 1100, New York with 900, and Illinois with 700 (RTA & OMC, 2002).
3.1.1 **California**

This section concentrates on exploring the Bay Area metropolitan wireless cluster within the larger California regional cluster. California hosts more than 2,000 wireless companies that employ in excess of 60,000 persons. This makes it the largest state in the United States and one of the world main clusters in terms of size and concentration of wireless activities. From 1993 to 2001, venture capitalists invested more than $5 billions in the California wireless industry sector (RTA & OMC, 2002). In comparison, Texas, the next leading state in wireless activities, had only 1,100 companies, employed 34,000 employees and received $1.2 billions venture capital funding (ibid). In spite of the large size and importance of its wireless sector, California State is not the base of any major national wireless or data carrier. Neither is it the home of any dominant infrastructure or handset manufacturer. Instead, California’s wireless sector strengths lay in industries that support the core infrastructure, such as chips and device development, and in software and services. The bulk of the Californian wireless sector activities is concentrated in three metropolitan regions: San Diego, Los Angeles and the Bay Area.

3.1.2 **Bay Area Wireless Cluster**

The Bay Area is the metropolitan region that includes three geographically close cities: San Francisco, Oakland and San Jose. The region is known to draw some of the best professional talents in the ICT sector. This is supported by the fact that the region’s telecommunication industry employee earned on average US $77,521 in 2001; which is the highest average telecommunication industry wage across the United States’ economic regions (Institute for Strategy and Competitiveness, 2001). The region also has one of the highest average numbers of patents per employees in the country, which is 27.87 patents per 10,000 employees compared to 7.71 for the United States as a whole (ibid).

Among California metropolitan wireless clusters, the Bay Area ranks second in terms of size after Los Angles. In 2001 it employed around 22,500 people and has more than 600 firms. However, it significantly surpasses the other two areas in terms of venture capital expenditure that totalled close to $4 billions and employment growth that increased by 257% between 1993 and 2001 (RTA & OMC, 2002).

Three key factors contributed to the emergence of the Bay Area wireless cluster:

- Defence industry: historically the area was home to Fairchild, a major semiconductor supplier to the defence industry. This company spawned the creation of many large companies such as Intel and paved the way for the creation of a strong ICT cluster.
The United States government continues to invest significant defence R&D budgets in the region.

- ICT cluster: the region is the base of one of the world’s major ICT cluster with companies such as Intel, Oracle, Sun and 3Com.
- Venture capitalist: the region is also known for the presence of an extremely high concentration of venture capitalists. These investment institutions backed the creation of numerous start-ups, which targeted the wireless sector for its high growth and potential.

Benefiting from the presence in the region of well-developed satellite and software industries, the Bay Area wireless cluster is particularly strong in the following fields:

- Satellite telecommunication equipments
- Enterprise access software
- Carrier class management software and applications

With regards to research, many Californian universities spearhead advanced research in wireless communication although they are not all located in the metropolitan area. These centres include:

- Stanford University – Wireless Communications Research (WCR) Group
- University of California Los Angeles – Wireless Integrated Systems Research Group (WISR)
- University of California San Diego – Center for Wireless Communications
- The California Institute of Telecommunications and Information Technology – Cal-(IT)2
- California Institute of Technology – Lee Center for Advanced Networking

In summary, the Bay Area wireless cluster is a very sizeable grouping of large and small companies engaged in diversified sub-sectors, most notably satellite communication, enterprise access and carrier management software. In spite of its size and maturity, the cluster is still growing and evolving. The wireless companies in the region maintain close relationships with local universities and suppliers. In addition, microelectronics, software and investment, which are important to wireless telecommunication industries, are well developed in the region. The Bay Area cluster’s various characteristics are summarized in Figure 10. This cluster stands out for its growth and the fertile entrepreneurial environment it presents, which are favourable to the expansion of mature companies and the creation of start-ups.
3.2 Finland

Finland has been the focus of numerous studies and research for being the best nation in the world in terms of its use of networking and information technology. Finland extends over 337,030 square kilometers, of which 10% is water and 69% is forest. It has a population of 5.2 million people, with two thirds living in towns or urban areas (CIA, 2004).

During the 1990's, Finland succeeded in performing an extraordinary economy conversion from being based on forestry and metal to relying on knowledge and high technology. This transformation was not limited only to the industrial and economical structure but extended to the social and cultural fabric. The International Institute for Management Development ranked Finland as the world’s most “competitive nation” with a population of less than 20 millions in 2003 (International Institute for Management Development, 2003). “Competitiveness of a nation” is defined as “a field of economic knowledge, which analyses the facts and policies that
shape the ability of a nation to create and maintain an environment that sustains more value creation for its enterprises and more prosperity for its people” (Garelli, 2003, p. 702).

The ICT sector has played the major role in this transformation and success. This sector generates about 30% of Finland’s exports (Paija, 2000). Several of these facilities may belong to the same organization. The development of the ICT is attributed to three primary factors (TIEKE, 2003):

- Sparsely populated country with extremely long distances
- Heavy investments made in education and R&D
- Well-functioning regulatory environment

Related to the last point, Finland has never had one single incumbent telecommunication provider. Instead, dozens and sometimes hundreds of companies were competing to provide services and products. The government, via a state owned company, had an active role in ensuring compatibility and connectivity between all these companies. In the early 1990’s this state owned organization was privatized. The early liberalisation of the telecommunications market in Finland might be the catalyst to the success and growth of the ICT sector.

Additionally, Finland adopted a unique governmental policy that helped the rapid adoption of wireless cell phones in the country. The government granted for free the rights for firms to operate within the cellular bands of the radio spectrum (Kuusipalo et al., 2001). This allowed the local companies to have quick access to a strong home base demand for innovative products. This is a contrast to most other developing countries, where governments opted to charge the telecommunication operator heavily for licensing the rights to portions of the radio spectrum. These policies have been blamed for significantly slowing down the spread of wireless telecommunication as well as the advancement and technological infrastructure upgrade in these countries, most notably the United States, because of the restriction and extra licensing fees.

As shown in Table 3, Finland has one of the highest cell phone ownerships per capita in the world. Nine of every ten Finnish residents have a cell phone. In recent years, the high percentage of wireless cell phone subscribers as part of the total phone subscribers has resulted in an increasingly significant portion of the households completely abandoning wireline phones and exclusively relying on wireless technologies.

3.2.1 Helsinki Wireless Cluster

With a population of about a million, Helsinki area hosts a large proportion of Finland’s companies involved in the ICT sector. The wireless cluster, or mobile cluster as it is generally
known in Europe, is one of the fastest growing and major components of ICT. It is difficult to separate wireless activities and statistics from the rest of ICT activities in Helsinki. Helsinki is the home of Nokia, the world’s predominant supplier of mobile phones. Nokia had a 30% worldwide market share in 2002. There are about 9,000 single offices or manufacturing facilities that are ICT related in the Helsinki area, of which 78% have fewer than 4 employees and 19% between 5 and 50 employees (Tukiainen, 2002, p. 12). In 2000, the Helsinki ICT industry employed about 100,000 persons (ibid, p. 14). In the same year about 1,500 ICT start-ups were registered in Helsinki (ibid, p. 15). This denotes the entrepreneur culture of the country and makes it challenging to determine the number of firms in the narrow wireless cluster. As the major part of the ICT clusters, it is reasonable to estimate that the number of wireless companies would number more than a thousand. Nokia is the major actor in the Helsinki cluster and is the anchor of the wireless and the ICT clusters.

The Helsinki wireless cluster (Nummi & Lahenius, 2003) is composed of:

- **Nokia**, the giant mobile phones and network equipment vendor.
- Four other large companies: Sonera and Elisa, both telecommunication operators, as well as TietoEnator and Novo Group, providing internationally various tailored services, software for different environments, and IT consulting.
- R&D facilities for Siemens and Ericsson, also international wireless handset vendors and networks from Germany and Sweden.
- A pool of small and medium companies which deal mainly in software support and services to the other large players.
- Four universities and three polytechnics Institutes involved in research, especially Helsinki University of Technology.
- Finnish venture capitalists, most of whom are located in Helsinki.

The intense competition in providing telecommunication services in Finland “creates an ideal environment for application developers to create and test their products. Also the high penetration rate of mobile phones enables to test application efficiently” (Nummi & Lahenius, 2003, p. 2).

The collaboration between university and industry is very intense and contributes to the expanding innovation in the region. “The telecom operators and companies in electronics business have usually formal collaboration with universities whereas the software companies are mainly depended on universities as a source of skilled labor” (ibid, p. 11). Figure 11 summarizes the characteristics of this cluster using the cluster diamond tool.
Over the years the Helsinki wireless cluster has gained a worldwide reputation. The core of the cluster is the giant company, Nokia. The cluster overall has reached the maturity stage. However, the momentum reached in the region is creating initiative to rejuvenate the cluster and pursue emerging growth opportunities. The cluster benefits from an outstanding supporting structure provided by the local economic and societal environments, which has proved to be mutually benefiting.

Helsinki Wireless Telecommunication Cluster

3.3 Canada

Canada, as the geographically second largest country in the world, has an inherent incentive to develop and deploy wireless solutions and networks. Surprisingly, compared to other developed countries, Canada has one of the lowest wireless penetration rates with only 41% of the population having cell phones (see Table 3). The number of wireless phone subscribers as portion of the total telephone subscribers is merely 40%.
For many years public policy has been promoting innovation and regional development. ICT is among the sectors that have benefited from this policy. Industry Canada identifies several ICT sector groupings across the country (Table 8). A grouping with significant size is labelled a ‘cluster’; otherwise the grouping is called a ‘spotlight’.

<table>
<thead>
<tr>
<th>Location</th>
<th>Networking Technologies</th>
<th>Core Technologies</th>
<th>Software &amp; ICT Services</th>
<th>New Media</th>
<th>ICT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vancouver</td>
<td>Wireless</td>
<td>Photonics</td>
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<tr>
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<td>Edmonton</td>
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<td>Northwest Territories</td>
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<td>Saskatchewan</td>
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<td>E-business</td>
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<td>Photonics</td>
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<td>New Brunswick</td>
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<td>E-business</td>
<td>E-learning</td>
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<td>Newfoundland</td>
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<td>Marine Com</td>
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Table 8 - ICT Clusters in Canada

Within the ICT sector, two wireless clusters are recognized in Vancouver and Calgary. A wireless cluster under development is identified in Ottawa (Industry Canada, 2004a). The

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19 Source: Industry Canada (2004a)
Calgary and Ottawa clusters are analyzed in the following two sections, while the Vancouver cluster is the subject of an extensive study in the next chapter.

3.3.1 Ottawa

Ottawa telecommunications equipment cluster is one of the most developed and mature high technology clusters in Canada. The Ottawa region has more than 212 companies engaged in the telecommunication industry (Industry Canada, 2004a), including centres from international telecommunication leaders such as Nortel, Alcatel, JDS Uniphase, Cisco Systems and Nokia. About 80,000 people are employed in advanced technology industries in the region. In addition to telecommunications, the region is also known for having strong industries such as microelectronics, photonics, software development, and professional services. The Ottawa region is home base to national wireless access providers such as Bell Mobility and Rogers AT&T.

The emergence of a wireless cluster in the area is mostly due to local mature telecommunication companies extending their activities to include new wireless applications and products. Around these large companies, a grouping of smaller companies and start-ups specializing in niche wireless applications has formed over the past few years. Currently the Ottawa wireless cluster includes about than 70 companies (Ottawa Global Marketing, 2004a) and employs 1,500 persons (Deloitte, 2004).

From a historical point of view, the principal factors that have contributed to the emergence of the Ottawa wireless cluster include:

- **ICT cluster:** The high demand and the growth prospects for wireless devices and infrastructure pushed some of the established companies involved in telecommunication to move into wireless applications. This move was facilitated by the availability in the area of the talents and resources required. “There is increasing evidence to show growth in the Ottawa wireless sector in the last few years. Wireless is at the intersection of several sectors such as telecommunication, semiconductor, software and services” (Santos & Krishnapillai, 2002, p. 11).

- **Strong research and development facilities:** Industry Canada estimates that 90% of Canadian telecommunication R&D takes place around Ottawa (Industry Canada, 2004b). The Communications Research Centre, Ottawa Centre for Research and Innovation, and the National Research Centre located in the Ottawa area are spearheading advanced wireless research in several fields. For example, “the Ottawa based Communication Research Center (CRC) is one of Canada’s best antenna research centres”. (Santos & Krishnapillai, 2002, p.
In addition to employing a large number of professionals in wireless research, these centres have created company incubator facilities and helped start-ups begin operations. Additionally, the region has three universities actively engaged in research: Ottawa, Carleton and Algonquin.

- **Home based demand for wireless applications**: a survey conducted in the region in 2004 has shown that 73% of wireless industry revenues originate from Canada. Furthermore, more than half of the revenues originate from the Ottawa region itself. Very few revenues are being generated from overseas clients (Deloitte, 2004, p. 10).

  A study by the global consulting firm Deloitte (2004, p. 4) identified "software development and solution development/consulting as the most common types of wireless activities." Other fields of specialization include:
  - Enterprise solutions
  - Satellite equipment
  - Communications interface devices

  The same study found that "wireless companies have demonstrated their ability to stay in the market place, with close to 70% of respondents having been in the industry for over 2 years, including one-third that have over 10 years of wireless experience" (Deloitte, 2004, p. 5). This is evidence for the stability of the cluster in spite of the challenges that have faced the ICT following the technology bubble burst.

  In the field research, in addition to CRC, the region’s universities are actively involved in the wireless research and technologies (Ottawa Global Marketing, 2004b):
  - University of Ottawa, the School of Information Technology and Engineering (SITE) is working on the development of mobile telephone protocols.
  - Carleton University, through its world-class wireless researchers and broadband communications lab, is teaming up with Ottawa’s National Capital Institute for Telecommunications to create a new Centre for Wireless Research. The centre will provide access to a wealth of wireless expertise and equipment, while conducting research into the next generation of wireless systems, both mobile and fixed.

  One of the major hurdles facing the development of the Ottawa cluster is the absence of a “prospective company to become the local wireless anchor” (Santos & Krishnapillai, 2002, p. 16). The anchor company has an important role in promoting the cluster and managing the dynamics for bringing the cluster together. Another challenge faced by the emerging local industry is the limited availability of venture capital in the region (ibid, p. 17). An initiative
called Ottawa Wireless Cluster (www.OttawaWirelessCluster.com) has been created by the Ottawa Center for Research and Innovation (OCRI) to promote and build the cluster. Currently the Ottawa wireless cluster is at an early stage of development. Figure 12 presents the cluster diamond analysis for the Ottawa region wireless industry.

![Ottawa Wireless Telecommunication Cluster](image)

**Figure 12 - Ottawa Wireless Cluster Diamond Analysis**

### 3.3.2 Calgary

Calgary is the heart of economic and industrial activities in the Province of Alberta. Since the early 1980s, Calgary has been a centre for leadership in wireless innovation. Currently, it is the home of more than 100 companies specializing in various fields of wireless telecommunications. These companies employed around 12,000 persons in 2001. The development of the Calgary cluster is attributed to three main reasons (Industry Canada, 2004b):

- Oil and gas industry: “There is a little doubt that it was the needs of oil and gas industry that stimulated the key events at the foundation of the Calgary wireless cluster” (Langford et al.,...
2001, p. 1). Prospecting and exploration in remote areas requires transport of large amount of geological and logistical data to research centres across long distances of unpopulated land. Wireless transport is very suitable because it allows the flexibility in moving the exploration sites and relatively low investment compared to wireline infrastructure (ibid).

- NovTel: In 1982, a partnership between Nova Corporation, the largest company collecting and transporting gas across Alberta, and Alberta Government Telephones (AGT) that later would become Telus. NovaTel is accredited for deploying, in 1993, the first cellular network in North America. NovTel also developed handheld devices that captured, at one time, half of the North American market share (ibid). Many of the current companies trace their origins to NovTel either through spin-offs, partnerships or transfer of employees.

- Nortel: This company has large telecommunication equipment manufacturing facilities located in the region.

The wireless research in the region is lead by:

- TRLabs Wireless Research Centre (cooperation between industry, government and universities)
- University of Calgary
- iCORE

The qualified workforce in the region is considered to be the major asset of the region. "The labour force is the central node that grounds the wireless cluster in Calgary and from it stems a regional system of innovation" (Langford et al., 2001, p. 15). There are strong community links in the region between wireless professionals that contribute to the emergence of "a constellation of firms enjoying rich knowledge flows, largely mediated ‘on foot’ or in conversation among close associates" (ibid, p. 16). In comparison with other wireless clusters, Calgary firms have strong expertise in communication systems integration into complete solutions. These firms differentiate themselves through "efficient import of technology and science from the global knowledge system, its efficient configuration to create new knowledge and add value, then successful export of product to a world market" (ibid, p. 16).

Although the Calgary region has a history of individuals and firms collaborating and sharing knowledge, these interactions remain informal and lack the focus and drive to enhance the cluster. It is only last year that an initiative called Wireless City (www.WirelessCity.ca) was instigated to promote the Calgary cluster.

The Calgary wireless cluster appears as a growing cluster with solid roots in wireless applications development and proven past performances. The cluster size is medium with
numerous companies focusing on GPS technologies and system integration. Although the cluster has a long history and anchor firms, it hasn’t developed formal structures for facilitating cooperation between the firms until this year. Figure 13 summarizes the cluster diamond analysis for the Calgary region.

![Calgary Wireless Telecommunication Cluster](image)

**Figure 13 - Calgary Wireless Cluster Diamond Analysis**

The analyses of these different clusters reveal a wide variety in terms of structures, origins, internal dynamics and levels of maturity, despite a common goal to pursue a high growth industry. In particular, this small sample suggests that there may be no universal formula or strategy to create and make a cluster successful. These clusters rely on the presence of related industries and well-developed academic and research environments. The analysis of these clusters serves as a comparison against which to analyse and understand the Vancouver cluster. This analysis appears in the next chapter. The last chapter extends this analysis into recommendations for the improved management of the Vancouver cluster.
4 VANCOUVER WIRELESS TELECOMMUNICATION CLUSTER

After defining the general context of the wireless telecommunication industry and analysing a sample of its particular regional groupings, the rest of this study focuses specifically on the particular Vancouver grouping. This chapter investigates the structure, dynamics, and characteristics of Vancouver’s wireless telecommunication cluster.

4.1 Vancouver Technology Industry Overview

The province of British Columbia’s technology sector employed 45,550 people and generated revenues in excess of $6 billion in 2001. The sector was responsible for 2.9% of the province’s GDP. It also employed 2.9% of the entire provincial workforce but was the origin of 4% of aggregate salaries. Most importantly, for the last 10 years, the high tech sector has been growing at an average rate of 6.3%, which is twice as fast as the average rate for the rest of the province’s economy. The bulk of the high tech activities is concentrated in the Greater Vancouver Regional District.

The technology sector in British Columbia is very varied. However, in recent years a few distinctive concentrations have formed to constitute the base of five distinct clusters (PriceWaterHouseCoopers, 2003). In addition to the wireless cluster there are:

- **ICT**: This is a mature and large cluster responsible for the majority of the high tech contribution to the province’s GDP. There are more than 5,000 companies participating in this sector. For the most part their activities are related to electronics and software.
- **New media**: This cluster group consists of companies engaged in activities related to interactive multi-media products and services. Electronic games, e-learning software and web-related services are some of the most important sub-categories. About 700 companies operate in this cluster.
- **Fuel cells**: This cluster includes more than 25 companies participating in various parts of the fuel cell industry value chain.
BioTech: 43 companies operate in this cluster engaged in developing pharmaceutical, therapeutic and genomic products. Because of the large investment in R&D, this cluster is expected to grow at phenomenal rates in the following years, when the innovations are fully commercialized.

4.2 Vancouver Wireless Cluster Anatomy

4.2.1 Origins

Historically, the wireless industry in Vancouver, and by extension in British Columbia, traces its origins as early as the 1960s. Three companies had a major impact on forming the local industry (Langford, 2004):

- **MDI** (Mobile Data International) was founded by Macdonald Dettwiller and Associates in 1978, and then bought in 1988 by Motorola to become its Wireless Data System Division. In the early 1990s, MDI employed more than 1,000 people and had $100 million in revenue.

- **Glenayre** (founded in 1963) during the 1990s it managed to position itself as a world leader in mobile data systems and pagers and employed more than 600 people. Glenayre went bankrupt in 2001, after the demise of the wireless paging market.

- **MPR-Teltech**, founded in 1979 by BCTel, existed until 1986 and provided up to 700 jobs. It disbanded in 1986 when BCTel (which would become Telus later) decided to adopt a “follower strategy that does not support the innovation and research thrusts of MPR” (Langford, 2004, p. 3).

These companies reached significant sizes and were leaders in their respective fields. They shaped the wireless industry in Vancouver. They also constituted solid industry anchors for the Vancouver cluster for more than two decades before they ceased to exist. Most of the companies currently participating in the local wireless industry have either direct or indirect connections with one or more of these three companies either thorough technology or people transfers (PriceWaterHouseCoopers, 2003).

4.2.2 Cluster Economical Characteristics

Currently, about 100 companies in the Vancouver area have direct activities in the wireless industry, excluding consumer retail stores. A previous survey of 67 companies within this cluster conducted in 2001 (PriceWaterHouseCoopers, 2002) revealed that:
About 1,500 people were employed in the cluster and this number was expected to more than double in the following three years.

The companies surveyed generated $253 million in 2001. Ten of these companies were responsible for 95% of total revenues.

The cluster exported 61% of its products and services. The US was the major destination and was responsible for 42% of the total revenues. The Asia Pacific area was responsible for 9% and Europe 8%. Revenues originating locally or from other parts of Canada constituted only 39%.

357 patents were filled.

Providing enabling software services and enterprise class solutions was among the activities of 48% and 37% of the respondents, respectively.

### 4.2.3 **Wireless Cluster Participants**

**Wireless narrow cluster**: the survey conducted within this project revealed that currently there are 89 companies in the Vancouver narrow wireless cluster. Further details about the survey are presented in Section 4.3 Company Survey. The sample of these firms presented in Table 9 shows a variety of business specializations.

**Wireless broad cluster**: about 50 more companies and organizations provide related and supporting services to the wireless narrow cluster. These include, for example, electronic manufacturing, marketing, consulting, legal services, and technical services firms.

**Education and research institutions**: The Vancouver area has two large universities and one technology institute actively engaged in wireless research:

- Simon Fraser University: The Centre for Systems Science (CSS) is a research organization, which promotes advanced research in computers and communications, microelectronics, and intelligent systems. The centre has more than twenty years of wireless research with a large portion of it in cooperation with local companies. SFU also has the Communication Networks Laboratory, where “current activities encompass wide area and wireless data networks, with emphasis on traffic collection, modeling and characterization, and on performance analysis of packet and ATM networks” (SFU, 2004).
<table>
<thead>
<tr>
<th>Company</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Games</td>
<td>Global provider in publishing and distributor of mobile entertainment products.</td>
</tr>
<tr>
<td>Colligo Networks, Inc.</td>
<td>Provider of peer-to-peer wireless productivity software designed for notebooks, Tablet PCs and handhelds.</td>
</tr>
<tr>
<td>Con-Space Communications</td>
<td>Provides two-way wired and wireless voice communication products for confined spaces and other hazardous work environments.</td>
</tr>
<tr>
<td>Digital Dispatch Systems</td>
<td>Provider of turnkey wireless mobile data systems for the taxi, courier, shuttle, vehicle tracking, and airport asset management industries.</td>
</tr>
<tr>
<td>Kinetix Wireless</td>
<td>Provider of leading edge mobile platform and wireless applications enabling Mobile Asset Management, Mobile Workforce Management and Mobile Field Service</td>
</tr>
<tr>
<td>Norsat International</td>
<td>Developer of portable satellite terminal products that provide rapidly deployable broadband satellite data and video connectivity.</td>
</tr>
<tr>
<td>Telus Mobility</td>
<td>Provides its three million clients across Canada with a full suite of wireless voice, Internet and data services through its Mike and PCS digital wireless network.</td>
</tr>
<tr>
<td>TRL Microwave Technology</td>
<td>Specializes in the research, development, and manufacturing of microwave and millimeterwave components for the satellite, terrestrial and wireless communications industries.</td>
</tr>
</tbody>
</table>

Table 9 - Vancouver Narrow Wireless Cluster Company Examples

- University of British Columbia: The Data Communications Group in the Department of Electrical and Computer (http://datacom.ece.ubc.ca) pursues research activities in wireless personal communication systems, internetworking of mobile and personal communication networks, wireless data networks for mobile computing, satellite networks, and other projects.

- British Columbia Institute of Technology: This institute trains technologists in various areas of telecommunication, device and equipment development, maintenance and installation.

WinBC: This is an initiative from the local private sector, which created a new organization to promote British Columbia’s wireless industry and promote cooperation, networking and knowledge sharing within the industry. This organization, called Wireless Innovation Network of BC, was founded in 2003. Its mandate is to bring “this diverse sector closer together by fostering collaboration among early-stage wireless companies in BC” (WinBC, 2004b). It also aims at creating “awareness of BC’s wireless sector as a geographic centre of

43
excellence in the research, development and deployment of wireless communications solutions” (ibid).

**CWTG:** Canada West Telecom Group is a public-private partnership founded by the BC provincial Ministry of Science, Competition and Enterprise. Its main objective “is to pool the resources of members to market their products and services in overseas markets and to provide quality telecom solutions worldwide” (Lee, 2004, p. 4). This initiative was particularly focused on helping British Columbian small companies penetrate the Asia Pacific region markets. It assisted these companies to overcome the limited availability resources in marketing overseas and their lack of experience in Asian markets.

**PriceWaterhouseCoopers:** This is one of the major global consulting firms particularly active in the technology sector. It has performed many studies about the local technology sector in British Columbia. Particularly, the Genealogical Map of BC technology firms (PriceWaterhouseCoopers, 2004), the BC Technology Clusters white paper (PriceWaterhouseCoopers, 2003) and the BC Wireless Industry Survey (PriceWaterhouseCoopers, 2002) are good references for understanding the local industry.

Other organization for cooperation in the region includes New MIC and British Columbia Technology and Information Association (BCTIA). Finally, its worth mentioning that two organizations funded by the Canadian Government, the Canadian Institute for Market Intelligence CIMI and National Research Council (Industrial Research Assistance Program NRC-IRAP), are investigating the local development in the region. The latter conducts studies about various technology clusters across Canada with a specific emphasis on innovation and R&D.

### 4.3 Company Survey

A survey of the companies constituting the Vancouver wireless narrow cluster was conducted within this project to determine the major business orientation of the cluster and reveal the presence of possible sub-clusters. This section presents the methodology, then synthesises and interprets the results of this survey.

#### 4.3.1 Survey Methodology

The identification of companies participating in the wireless industry was based on a review of several business directories. The sources of these directories include Wireless Innovation Network in BC (www.winbc.org), the Advanced System Institute of BC (2004) and other industry associations. The result of this research is the compilation of an exhaustive list
that enumerates all companies participating in the wireless telecommunication industry located in the Vancouver area. Then the particular information about each one of these companies was obtained from the Internet by reviewing, for example, the company website, and its public announcements and reports.

Eight categories of company information were considered for this study:

- **Product/technology/customer**: These are the three dimensions presented in the section about wireless telecommunication segmentation (refer to Figure 2, p.14). Each company was assigned to only one category in each dimension that corresponds to its primary activity.

- **Size**: This represents the number of employees in the company. For firms that have multiple locations or are involved in many industries, the size represents the number of employees based in Vancouver and involved in wireless telecommunication activities. In high tech companies the number of employees is generally an appropriate proxy for the firm’s magnitude of economic activity. Companies were categorized as small (less than 50 employees), medium (51 to 200) or large (more than 200). Only a few companies have data available about the exact number of employees. For all the others a subjective determination of the size was made based on the sophistication and diversification of their products or services, financial performance when available and the level of maturity of the firm.

- **Status**: This refers to whether the company is private or public.

- **Origin**: The location refers to where the company headquarters are located. Location was divided into four categories: Vancouver, the rest of Canada, the United States or elsewhere in the world.

- **Nature of activity**: this is a short description of the products or services, and nature of the company business activity.

### 4.3.2 Survey Results and Commentaries

Upon investigation, there are a total of 89 companies in the Vancouver area with direct operation in the wireless industry. The detailed list of these companies is reported in Appendix 2. The appendix also includes the information collected within this survey.

Figure 14 summarizes the distribution of Vancouver wireless companies by *ownership, origin* and *size*. The analysis of the results shows the following:

- The large majority of Vancouver wireless companies are home grown. 84% of the companies have their headquarters in Vancouver. Another 9% belongs to companies based in other locations in Canada. The remaining 7% are local subsidiaries of US based firms. This
data indicates that the wireless industry development in Vancouver is mainly the result of entrepreneurial initiatives from the region.

Figure 14 - Vancouver Wireless Company Distribution by Ownership, Origin and Size

- The results also reveal the surprising fact that no company outside North America has a wireless activity operation in Vancouver. Global wireless leaders like Nokia, Philips or Alcatel certainly have large research and development centres of excellence in Vancouver. However, these centres focus their research on fields other than wireless specific core technologies, such as networks, software development or new media applications. This fact suggests the possibility that Vancouver wireless industry may be relatively unknown outside British Columbia, and particularly outside North America.
- The majority (61%) of the companies are small in size. Only 10% are relatively large\(^\text{20}\). On the one hand, this attribute may be a reflection of the Vancouver cluster being in the development phase typically characterized by the abundance of start-ups. If this is the case, it is a healthy indication of the state of the cluster. On the other hand, considering that the

\(^{20}\) A large company in the context of this project means a company employing more than 200 people in wireless industry related activities.
wireless industry has more than 30 years of history in the region, this characteristic may be an indication of difficulties for local companies to grow beyond a certain size.

- Three quarters of the companies are private. In the current situation, this detail is congruent with the fact that most of these companies are small or medium in size. However, if the cluster continues growing and maturing, many of these companies would need to seek additional financing including initiating public offerings to support their expansion.

Based on the data collected, the companies were grouped into different categories depending on the product, technology and customer types. The result of this grouping is synthesized in Figure 15 and the upper row of Figure 17. Reviewing the results provides the following insights into the local wireless industry:

- The single narrow specialization with the highest concentration of firms is “enterprise software development” particularly in the field of “mobile data management, access and distribution through public networks”. About 19 companies specialize in this field.
- The other noticeable concentration is around “enterprise class equipment manufacturing” combining the various technologies used, where 21 companies participate. An additional 7 firms specialize in the related specialization of “carrier class equipment manufacturing”.
- Most companies are engaged in various aspects of enterprise wireless solution. This is congruent with the trends of wireless industry that indicate that the enterprise solutions sector is expected to be the main driver for future growth of the industry as indicated in Section 2.4.6.
- Very few companies are producing consumer products or marketing their products or services directly to consumers. Companies in Vancouver appear to favour narrow business-to-business (B2B) relationships. Even with “enterprise class application” Vancouver companies usually sell their products to enterprise solution providers and integrators rather than directly to corporate end-users. This observation suggests that Vancouver firms’ abilities for marketing, distribution and sales are rather limited and that their strengths lie more in innovation and R&D.
- Most companies develop products related to PCS or WLAN technologies. PCS based technologies are mature, standardized, well established and widely deployed across the world. WLAN based systems, on the other hand, are emerging technologies with a few standards shaping out. But the industry is still dominated by proprietary technologies especially for industrial applications. The absence of industry standards not only limits the
company’s capacity to cooperate with others but most importantly strategically forces the company to own a large part of its own industry value chain and restrict its ability to focus on selected core competencies.

Using the number of companies to analyze firm activities, specialization and concentration provide valuable insights on both the cluster’s composition and the direction it is heading. However, it doesn’t truly reflect the extent of the concentration of economic activity. The data is very skewed because of the high number of small firms and start-ups. For example, a
single large company such as Sierra Wireless or Telus Mobility may have revenues surpassing those of a dozen small companies. To correct this data skew, there is need to measure each company’s output and aggregate the results together for each concentration. However, in a competitive environment dominated by private firms, it is very difficult to obtain this type of information. An alternative to approximate the economical activity consists of appending a weight to each company depending on its size, then adding the individual companies’ weights by concentration instead of just counting their numbers. The weights are chosen so that a ‘large’ company would be on average four (4) times bigger than a ‘medium’ one; which in turn would be eight (8) times bigger than a ‘small’ firm. A small firm has one unit weight. The modified results are summarized in Figure 16 and the lower row of Figure 17.

The new distributions reflecting the size of economical activity reinforce the previous observation. Additionally they reveal that:

- “Providing wireless cellular services and consumer products” is the most important economical activity in the area, although only a handful of companies are involved in such activities. This result is expected considering that the company must be large in order to provide public wireless access.
- “Satellite geo-location services” using GPS and online web technologies appear as an important activity in the region. Theses services primarily involve enterprise asset tracking such as corporate vehicle fleet management or inventory management. They also involve determining location of people.

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21 The choice of these weights is justified by 2001 distribution of employment in wireless companies (PriceWaterhouseCoopers, 2002, p.9). Employment was less than 20 in 77% of the companies; 21-60 in 18%; 41-60 in 5%; and more than 61 in 5%.
Figure 16 - Vancouver Wireless Activity Concentration
Figure 17 - Vancouver Wireless Company Distributions
4.3.3 Wireless Cluster Mapping – Value Chains and Network

Based on the previous sub-section analysis, the Vancouver wireless cluster areas of high activity concentration are mapped to the value chains defined in section 2.3. They are marked by the dark shade on Figure 18. “Network Operator/Carrier” and “Service Provider” are local industries while “Conversion Software”, “Carrier Class Enabling Software”, “Enterprise Class Enabling Software” and both “End-User and Network Devices” are traded industries.

The most important observation that transpires from the value chain mapping is that the Vancouver wireless companies participate in disjointed portions of the global wireless industry value chains. More specifically, they do not specialize in any particular vertical market or value chain. A ‘vertical industry’ specialization is represented in Figure 18 as a horizontal value chain, while a ‘horizontal specialization’ is vertical. The “Access” value chain gives the impression of being locally integrated. In fact it is not. Local “Network Operators” and “Service Providers” are not generally users of the local carrier class “Enabling Software” products. The later sell their products mostly to US wireless network operators. The lack of local integration in industry value chains limits the ability of the Vancouver cluster to control its expansion, because it depends, both downstream and upstream, on segments located outside the geographical cluster.

There is, however, evidence of concentration around two horizontal activities, which are software and device development. This horizontal industry specialization reinforces the view that the Vancouver wireless cluster, in its current state of development, is reliant on factor conditions, especially the availability of skilled workers and talents in software and device development.

The Vancouver wireless cluster value network mapping represented in Figure 19 emphasizes the previous observations. Furthermore, it shows the wireless cluster positioning among some of the other Vancouver high technology clusters, such as electronic and telecom, new media, and software development. Excluding the “network operators” and “cellular service/device providers” as they belong to non-traded industries, wireless leading activities are located close to the periphery of the cluster, particularity near the intersection with the other clusters. This is an illustration of an important advantage of clusters whereby valuable opportunities may occur because of dynamic interactions and cooperation between geographically close clusters from different industries. As an example, many local firms specialize in wireless enterprise software to manage mobile workforce. This type of product is similar in nature to enterprise reporting or customer relationship management (CRM) produced
by leading companies such as Pivotal or Business Objects, which have a very large presence in the Vancouver software cluster.

The thin arrows on Figure 19 represent the channels of exchange between the Vancouver wireless industry sub-segments. They are drawn based on evidence of publicly disclosed partnerships or other forms of cooperation between firms, and interviews with individuals from a few companies and organizations participating in the industry. In spite of these channels being a subjective representation of cooperation between the firms, they highlight the fact that inter-firm exchanges and collaboration within the cluster are very limited.

*Figure 18 - Vancouver Companies Positioning on the Wireless Industry Value Chains*
4.4 Cluster Diamond Analysis

This section analyses the Vancouver wireless cluster using Porter's diamond framework to further characterize the cluster and expose its strengths and weaknesses on each determinant. This qualitative analysis is synthesized in Figure 20.
Vancouver Wireless Telecommunication Cluster

**Government**
- Academic research and education support
- R&D taxation benefits
- Innovation investment funds
- Supporting organizations

**Factor Conditions**

**Strengths**
- Natural environment
- Qualified & economical workforce
- Information and transportation infrastructure
- Pacific Region links
- Proximity to California regional cluster

**Challenges**
- Capital Resources

**Context for Firm Strategy and Rivalry**

**Strengths**
- WinBC
- Board of directors participation

**Challenges**
- Industry fragmentation
- Lack of large integrators

**Demand Conditions**

**Strengths**
- Niche marketing
- Centers of excellence
- Industrial and transportation applications

**Challenges**
- Low consumer demand
- Wireless access providers
- Deficiency of large companies

**Related and Supporting Industries**

**Strengths**
- Electronic manufacturing services and component suppliers
- Universities and research centers
- New media & enterprise software clusters
- Service companies

**Challenges**
- Small number of financing institutions

**Chance Events**

- Motorola's Wireless Data System Division
- Glenayre pioneering wireless data messaging

*Figure 20 - Vancouver Wireless Industry Cluster Diamond Analysis Summary*
4.4.1 Factor Conditions

The availability of factors appears to be the most important consideration behind the choice of many wireless companies to locate their operation in the region. Vancouver indeed has multiple attributes that are advantageous to the development of wireless industry in the region. The most important attributes of the area are:

- **Natural environment**: Vancouver is considered one of the best places to live. The combination of the natural beauty and variety; and the mild weather makes an excellent city for living and enjoying the surrounding landscape. The west-coast lifestyle and the natural wonders of the region directly influence the city’s ability to attract and retain both talents and entrepreneurs, especially those who like the outdoors or prefer an active lifestyle.

- **Qualified workforce**: as outlined in the section about the origin of the Vancouver cluster, wireless companies have existed in the region for decades. In addition, a considerable number of people graduate every year from universities at various levels of instruction. Many of these graduates have specialization related to the wireless industry. Thus, the universities are creating an expanding pool of qualified people.

- **Economical workforce**: the salaries of wireless workers in the region are low compared to the United States by all measures. For wireless companies, as it is the case for other high tech industries, payroll is by far the largest expense. A more economical workforce is certainly one of the most important reasons for many companies, especially the international ones, to locate in Vancouver.

- **Information and transportation infrastructure**: this is one of the benefits of large cities. They usually have good telecommunication infrastructure. In addition, airlines through the Vancouver airport connect to all major worldwide cities. The airport is one of the busiest in the country, which as a result offers of frequent and direct flights to most destinations. This makes it easier and more convenient to commute to any regions globally. Also, equipment and components can be shipped to other locations in North America within a day. The city also has good road network and public transportation that enables easy commute within the region.

- **Asia Pacific links**: As mentioned in sub-sections 2.4.5 and 2.4.6, a large part of the current wireless technology deployment and network innovation is taking place in Asia. Vancouver, compared to other Canadian cities, has the strongest links with the Asia Pacific region. Some of the conditions contributing to strengthen the relationship between Vancouver and the
Asia-Pacific region are the geographical proximity, frequent flights to the region, the port of Vancouver being the point of exchange of most the goods traded between Asia and Canada, and the presence in the metropolitan area of large communities originating from this region. This situation offers local companies advantages and possibilities to be able to export their products to the Asia-Pacific region. However, the evidence available suggests that this advantage is little exploited by the local wireless industry. Indeed, the 2001 industry survey conducted (PriceWaterHouseCoopers, 2002) shows that only 9% of the Vancouver wireless products and services were exported to this region.

- **Proximity to California regional cluster:** Vancouver is the closest Canadian city to California. A flight from Vancouver to San Francisco takes just a little bit more than two hours. This enables easy commuting between the two regions. Additionally, the fact that British Columbia and California are in the same time zone makes conducting business between the two regions more convenient.

However, the Vancouver area suffers from deficiencies that inhibit the expansion of wireless industry. The most important contributing factor is:

- **Capital Resources:** the region does have a few venture capital firms and investment funds. However, their resources are limited and insufficient for the region’s need. Also because of the small number of venture capitalists, they usually lack the sophistication needed to specialize in certain industries. As a result, the process and the requirements for obtaining funding are much more stringent and difficult than they might otherwise be. This is congruent with the results of a survey of the local industry (PriceWaterhouseCoopers, 2002), which revealed that “obtaining funding” is the second most important critical success factor facing wireless companies in Vancouver.

### 4.4.2 Related and Supporting Industries

The presence in the area of well-developed wireless related or supporting industries is an important characteristic strengthening the Vancouver cluster. The previous analysis revealed that many of the wireless companies’ sub-segment specializations are localized at the intersection with other clusters. Indeed, the variety of local industries creates unique business opportunities and gives the companies involved differentiating sets of strengths. The industries that most benefit the wireless industry in Vancouver include:

- **Electronic manufacturing services and component suppliers:** The presence in the region of a strong ICT cluster and the act that most high tech companies subcontract most of their
electronic manufacturing has been favourable to the development in the region of large electronic manufacturing and assembly facilities, such as Dorigo Systems and Creations Technologies. Beside the fact that these facilities are using state of the art technology, they allow the local high tech companies to have a quick turnaround for manufacturing equipment. Another important factor is the ability to speak face to face between the designers and manufacturers, which allow greater flexibility and quality control. The same conditions have also caused the major electronic manufacturers and suppliers to maintain local presence and representation to be able to better address the local needs.

- **Leading universities and associated academic research:** The institutions, described in Section 4.2.3, provide a fertile ground for enterprise-academic cooperation to innovate and produce new technologies. The situation is also responsible for providing qualified people in the region.

- **Software industry:** Wireless equipment is more and more reliant on software to ensure hardware platforms have flexibility, adaptability and versatility. It is much more economical and convenient to change the functionality through downloading new software than replacing part or all of the equipment. Wireless equipment also relies on general-purpose software such as operating systems, development tools, simulators etc. Thus the presence of a strong local software industry is beneficial to wireless companies developing products.

- **New media industry:** developing wireless content and application is one important driver for the wireless industry in general. Many of the software and content developed by new media companies for computers is transferable to wireless devices. This includes, for example, games, entertainment content, graphic optimization, and animation. The presence of a well-developed new media cluster is a considerable asset to the local wireless companies because of the synergies that are created between the two industries.

- **Service companies:** The Vancouver region is full of companies providing various types of professional services, such as consulting, accounting, financial, export import, freight forwarding, legal, marketing communication boutiques, and other services.

  The industries that need development in the region are:

- **The small number of financing institutions:** As outlined in the section about factor conditions, the local financing companies do not have sufficient resources and specialized expertise to support a large variety of entrepreneur initiatives and established companies’ expansions. Therefore, the Bay Area destination is often frequented by local CEO’s to secure financing for their local companies.
4.4.3 Demand Conditions

From the demand side, the emergence of wireless companies in the area has been mainly fuelled by:

- **Niche marketing:** Entrepreneurial individuals in the area continue to recognize niche opportunities based on the needs of sophisticated buyers, mainly in the United States, that could be more efficiently satisfied using the local factors.

- **Centres of excellence:** Large international companies, such as Motorola, Nokia, Alcatel and Philips, have located R&D facilities in the regions to take advantage of local tax benefits and the availability of talented but economical employees.

- **Industrial and transportation applications:** Many Vancouver companies are developing devices and integrating systems to enable local firms and organizations to deploy WLAN applications particularly for industrial and transportation use. These companies have developed systems using wireless technologies for fleet management, taxi dispatching and customer billing, and warehouse and inventory management. Then they progressively moved to marketing these products and services to other geographic areas.

However, the general observation about the local demand for wireless applications is that it is has been lacking scale and sophistication. This environment did not offer incentives for the development of wireless companies. This is different from cases such as the case for Calgary with the gas and oil industry demand, Nokia with the emergence of an information society in Finland, or the Bay Area with the demand of the defence industry. Some of the contributing factors include:

- **Consumer demand:** Cellular phone penetration rates in Canada lag behind most developing countries. There is no evidence that would suggest that rates in Vancouver would be much different from the national average. In general, the demand for wireless connectivity and new services has been relatively low.

- **Conservative attitude of wireless access providers:** The local wireless providers have chosen a technology follower strategy. Particularly they have refrained from deploying new network technologies and offering innovative services.

- **Absence of large companies:** The cluster does not have large exporting companies competing internationally. This environment has not been favourable to the creation of supporting industries. Large companies usually have sophisticated needs and require higher standards and performance from their suppliers, including the local ones.
• **Wireless spectrum band availability and licensing:** In North America, the slow and conservative government policies regarding spectrum licensing have slowed down network improvement and offering of new services. The licensing fees imposed on wireless operators increase the prices of wireless services and further restrict market development and usage penetration.

4.4.4 **Firm strategy, Structure and Rivalry**

Some the vehicles for cooperation in the local wireless industry are

• **Wireless Innovation Network of BC (WinBC):** This is an organization established by the local wireless industry in 2003, to promote cooperation between the local wireless companies. This organization has organized multiple social events to enable wireless participants to meet each other and exchange ideas. This year it has organized an innovation contest to spur on the rivalry between the firms.

• **Board of directors participation:** Executives from some companies in Vancouver also assume the position of director on the board of other Vancouver companies. This is a method for firms to cooperate, share experiences and influence each other’s strategies. Of course it presupposes that these firms do not compete directly against each other.

The elements that have been hindering the development of the cluster include:

• **Industry fragmentation:** The results of section ‘4.3 Company Survey’ have highlighted the fact that the local industry is fragmented. Particularly, there is a deficiency in terms of company specialization around particular value chains.

• **Lack of large integrators:** Large technology wireless industry integrators and solution providers could help the development of the cluster by offering possibilities for the development of smaller companies developing enabling technologies and products. That is the case for the Calgary clusters. However Vancouver lacks these types of companies.

4.4.5 **Chance Events**

There were events attributed that played a major role in the development of the cluster, the most important ones are:

• The decision of Motorola to locate its Wireless Data System Division in the area had a significant role in planting the seed of wireless activities in the region.
The liquidation of Gleynare had opposing effects on the cluster. On one hand it was a loss for the Vancouver wireless cluster of one of its anchors and industry leaders. Indeed, this company pioneered an important sub-sector of wireless data transmission. On the other hand, Gleynare employees have joined other companies in the area. This has contributed to knowledge and experience spillover. In addition, some of the former employees have established start-ups participating in the local wireless industry.

4.4.6 Government

The various levels of governments have not had a direct and specific role with regard to the local wireless industry. However, the public policies favourable to the high technology sector in general, have benefited the local wireless industry. They include:

- **Academic research and education support**: Vancouver area is home to two large universities and one technology institute. In an effort to reinforce innovation, the federal government, through various programs, has been sponsoring both fundamental and applied research. The provincial government has committed itself to not only increase funding for post-secondary skills training but to doubling the number of yearly graduates in computer science, and electrical and computer engineering by 2007 (Allan et al., 2002, p. 14). These types of skills are indeed crucial for the wireless industry.

- **Technology Partnership Canada**: This is a federal program in which the Canadian government contributes a portion of the R&D investment needed for the development of a marketable product or technology. The government gets back returns as royalties when the product is launched to the market. A few Vancouver wireless companies have benefited from this program.

- **Employee share option plan**: The British Columbia provincial government currently maintains a labour-sponsored fund, which represents the province’s largest venture capital fund. It entitles employees to receive 30% tax credits when investing in their companies (Allan et al., 2002, p.14). In addition to making investment funds available, it provides incentives for retaining employees.

- **R&D taxation benefits**: both the federal and provincial corporate taxation systems have significant advantages to companies having activities in the area. These benefits include better advantages in term of R&D expenses, capitalization and tax credits. For example British Columbia R&D tax credits are 20% and can be carried indefinitely (Frighetto, 2001, p. 50).
Firm incubation programs: BC Research Inc. is a major incubator that helps develop technology companies by providing office or lab space, management support and consulting to entrepreneurs. The Science and Technology Fund is another mechanism by which the province of British Columbia drives innovation commercialization initiatives through the enhancement of university-industry mechanisms. This Fund has continuously been increasing and has resulted in establishing industry liaison offices, technology transfer and business development centres in all the universities and even most of the colleges in British Columbia (Allan et al., 2002, p. 13).

Canada West Telecom Group (CWTG): This is another initiative of the provincial government to help the local telecommunication industry export its products and services especially to the Asian markets.

4.5 Comparison with other Wireless Clusters

The comparison of Vancouver wireless clusters to similar industry clusters in Helsinki, the Bay Area, Ottawa and Calgary is summarized in Table 10. Vancouver and Calgary clusters are similar with regards to having comparable size. But more importantly, because of their historical involvement in the wireless industry, both clusters have already emerged from the formation phase to be fully engaged in the development phase of their respective lifecycles. In contrast, the Ottawa cluster is still in an early stage of formation. The Bay Area and Helsinki clusters have reached maturity and significant sizes.

The Vancouver and Calgary clusters, being in the development phase, are still relying on factor conditions as the primary driver for the growth of the cluster. Once they reach critical mass, other factors may become more important. Some of these factors include wealth creation, in the case of the cluster becoming the base for multiple large and successful companies, or innovation production in the other case of the cluster developing a fertile and rich environment and supporting idea generation and incubation.

Each cluster has emerged from different conditions. This has resulted in theses clusters having very different characteristics, strengths and specializations. These various clusters do not compete directly for customers or markets with one another because they serve different markets.

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22 BC Research Inc. was founded in 1944 by the provincial government, and then it was taken public in the beginning of 1990s after running into financial difficulties.
and segments. However, The Canadian clusters do compete among themselves for attracting global firms to establish activities in their respective regions. The Vancouver wireless cluster may particularly benefit from synergies with both the Bay Area and Calgary clusters. Collaboration possibilities with the Ottawa or Helsinki clusters are less obvious, mainly because of remoteness and less specialization commonality. There is evidence of significant collaboration between Vancouver and the Bay Area clusters. Surprisingly there are very few signs of actual cooperation between Vancouver and Calgary wireless companies.

Ottawa and Vancouver both suffer from the lack of anchor firms. However, the Vancouver cluster has the benefit of previously having anchor firms that helped shape the industry. Additionally, a few companies in Vancouver, such as Sierra Wireless, are gaining critical mass, which will enable them to potentially lead the cluster.

The limited collaboration with the local wireless carrier and service providers is one particular disadvantage that the Canadian wireless industries in general have been facing. Such a collaboration, that benefits both parties, has been instrumental to the growth of the Helsinki wireless cluster. The availability of venture capital resources has also restricted the growth of the Canadian wireless industry clusters.

Compared to all the other clusters, one of the disadvantages of Vancouver’s wireless industry appears to be the lack of a solid local demand base and reliance on other regions’ needs.

4.6 Analysis of the Strategies of Sample Firms

In this section the cases of three Vancouver wireless companies are examined. In addition to investigating typical strategies adopted by Vancouver firms, this analysis allows pragmatically exploring aspects of the derived benefits from the presence in a cluster.
<table>
<thead>
<tr>
<th>Cluster</th>
<th>Number of firms</th>
<th>Firm size</th>
<th>Development stage</th>
<th>Population (in millions)</th>
<th>Number of employees</th>
<th>Anchors</th>
<th>Origins of cluster</th>
<th>Primary and secondary driving determinants</th>
<th>Specialization</th>
<th>Supporting industries</th>
<th>VC Funding (in $ millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helsinki</td>
<td>150</td>
<td>Several medium</td>
<td>Developing</td>
<td>61</td>
<td>1</td>
<td>Nokia</td>
<td>Information society</td>
<td>Handsets; networks</td>
<td>ICT</td>
<td>Industry</td>
<td>$4,000 (1993-2001); average: $445/year</td>
</tr>
<tr>
<td>Calgary</td>
<td>100</td>
<td>2 large</td>
<td>Developing</td>
<td>61</td>
<td>1</td>
<td>Nortel, Norel</td>
<td>Telecom cluster</td>
<td>1- Factors</td>
<td>Gas &amp; oil</td>
<td>Oil &amp; gas</td>
<td>$116 in 2001</td>
</tr>
<tr>
<td>Ottawa</td>
<td>61</td>
<td>Small companies</td>
<td>Emerging</td>
<td>61</td>
<td>1</td>
<td>- none -</td>
<td>ICT cluster, defence</td>
<td>1- Investment</td>
<td>2- Innovation</td>
<td>Telecom; software</td>
<td>ICT, software, new media</td>
</tr>
<tr>
<td>Bay Area</td>
<td>600</td>
<td>Several large</td>
<td>Growing</td>
<td>61</td>
<td>1</td>
<td>3Com, Intel</td>
<td>Enterprise software</td>
<td>1- Wealth creation</td>
<td>2- Innovation</td>
<td>Enterprise software, services</td>
<td>ICT, software, new media</td>
</tr>
<tr>
<td>Helsinki</td>
<td>+1,000</td>
<td>1 very large</td>
<td>Maturing</td>
<td>61</td>
<td>1</td>
<td>Nokia</td>
<td>Information society</td>
<td>1- Wealth creation</td>
<td>2- Innovation</td>
<td>Enterprise software, services</td>
<td>ICT, software, new media</td>
</tr>
</tbody>
</table>

**Clusters Comparison Summary**
4.6.1 Sierra Wireless Inc.

Sierra is a relatively large public company in the Vancouver wireless data communications industry. The company revenues for 2003 surpassed $US 101 million while it spent $US 16 million in R&D. The company was initially incorporated in 1993. Over the years, it completed many acquisitions of firms related to its activities in Canada and the United States. During the late 1990s the company was specializing in wireless data modems with three product lines. These different product lines use the same core technology but commend different distribution strategies: (a) PC cards are sold through wireless service providers such as Verizon or Telus and a few independent telecommunication resellers; (b) ruggedized vehicle-mounted modems are marketed directly to corporate end users such as law enforcement agencies, public safety services and transportation organizations; (c) OEM modules are embedded by manufacturers of computers and other devices into their products to provide wireless access functionality.

The company adopts a differentiation strategy based on “delivering best-in-class customer and channel partner satisfaction based on pre- and post-sales resources, programs and information” (Sierra Wireless, 1999a, p. 16). The strategy additionally involves advancing “product quality and reliability” and aggressively investing “in its own intellectual property portfolio and, where appropriate, acquires or licenses technologies from third parties” (ibid). The company also views “strategic relationships within the wireless communications, portable computing and internet industries as critical to maximizing sales opportunities and optimizing next generation technology investments” (ibid).

Encouraged by its strong growth and success in the past few years, Sierra Wireless continues to target the “wireless data industry” as it believes it is “still early in the adoption cycle” (Sierra Wireless, 2003a, p. 2). It has also extended its activities further down the value chain by entering the Smartphone market tabulating on the company “background in enterprise wireless data” and the “existing channels and relationships” (ibid, p. 3).

The relationship between Sierra Wireless and the Vancouver cluster is mutually beneficial. Sierra Wireless benefits from both the advantages presented by the governmental policies and the availability of a qualified yet economical workforce. The company also gains advantage from the wireless research in local universities. For example, at the end of 2003 it announced the donation of $430,000 to create the Sierra Wireless Chair in wireless telecommunications in Simon Fraser University, School of Engineering Science, and support
research in this field (Sierra Wireless, 2003b). Additionally, the company benefits from the local presence of supporting industries especially electronic manufacturing as mentioned in a company report: “on the supply side, we outsource all production, most procurement and some business services to our partners” (Sierra Wireless, 1999b, p.5). The presence of Sierra Wireless in the region has also spawned a few companies, such as Oballa Consulting, that use Sierra Wireless technology to build custom solutions for fast, secure and reliable wireless access to corporate information and systems, or Cypress Solutions, which builds wireless rugged modems with integrated GPS and provides engineering services. Considering its size, growth and active involvement in supporting the local industry, Sierra Wireless is emerging as a potential anchor for the Vancouver wireless telecommunication cluster.

### 4.6.2 Spectrum Signal Processing Inc.

Spectrum is a medium sized public company. It generated in 2003 about $US 20 million in sales and spent more than $US 4.7 million in R&D. Spectrum was founded 1987 and has gone through several transformations over the years. During the 1990s the company specialized in producing innovative general purpose digital signal processing electronic cards that were used as part of sophisticated industrial equipment such as semi-conductor production equipment, medical imaging such as scanners, and military applications such as radar. In 2000, the company shifted from the general-purpose markets to very specialized sub-segments and accelerated “its expansion into the fast-growing digital wireless and wireline telecommunications infrastructure markets” (Spectrum Signal Processing, 2000). Currently, the company specializes in developing processing elements for satellite and military wireless telecom applications. From this brief historical overview, it is evident that the company has constantly adopted a focus strategy and oriented itself to serve the needs of sophisticated buyers in specific parts of the world, especially in the United States.

Reviewing Spectrum’s public announcements and releases reveals that similarly to Sierra Wireless, the company may be gaining advantages from two aspects of the Vancouver cluster. The first element is favourable government policy, especially provincial tax incentives and federal government support through two “Technology Partnership Canada” investments. The second element is the availability of factor conditions, especially a workforce that is very qualified yet inexpensive compared to other places in North America. The company considers its employees as its best assets; which is illustrated, for example, by its selection as the “#1

Spectrum has its headquarters in the Vancouver region. However it maintains three regional offices in the US in Maryland, California and Texas. Each one of these states is the base of one of the major wireless industry clusters in the United States. Thus, the company is reaching to the strength of other wireless clusters. This is also a means to overcome some of the disadvantages of the absence of local demand and the unavailability of interaction with sophisticated local buyers.

4.6.3 Epic Data Inc.

Epic Data is a medium sized software company. In 2003, the company revenues were US$ 26.5 million, and its R&D spending amounted to US$ 2.3 million. Since its inception in 1975, Epic Data has gone through three major strategic changes. In its first phase of existence, the company focused on the design, manufacture, and sale of data collection terminals (fixed and mobile keypad devices) and custom software that enabled these terminals to collect and transmit data for use in various business systems such as warehousing, manufacturing plant operations and access security (Epic Data, 1998).

The second phase started in the mid 1990s when the company recognized the “opportunity to use its experience and engineering capability to provide data collection sub-systems to organizations using or implementing ERP systems” (Epic Data, 2000, p. 2). During this period enterprise-wide management information and control systems started being widely implemented by organizations. The company developed a line of software products consisting of ‘middle-ware’ to link an organization’s data capture network with its application software or chosen ERP software. The company marketed and sold its products throughout North America and Europe both directly to large organizations that implemented an ERP solution, and indirectly through consulting firms, assisting companies to implement ERP systems, that act as value added resellers. The company was able to develop a large installed base and partnerships with major consulting firms.

The third phase started in 2000, after company revenues from its core activities stopped growing (ibid). This stagnation was mainly due to dramatic decline in enterprise IT spending following the ‘technology bubble burst’. Reacting to this change, the company launched new

23 ERP: Enterprise Resource Planning
software product lines for “development and deployment platform for mobile wireless and data collection applications; application products for mobile and data collection markets that are designed to interface with enterprise applications” (Epic Data, 2003, p. 3).

This last transition marked the company’s full entry into the wireless industry. Unlike ERP based products that were mainly targeted to large customers in the United States, the wireless products were initially deployed locally. The company adopted a focus strategy and chose to “enter the wide area wireless market principally through the government vertical market” (ibid, p. 10). For instance, the company’s first “parking ticket issuance” real-time system was deployed in 1999 as a pilot project in the City of Vancouver (Epic Data, 1999).

With regard to the interaction with the local clusters, this last example indicates that the company started drawing from the sophistication of the local demand to develop innovative solutions to be marketed worldwide. Additionally, it leveraged its experience in data capture solutions and interface with enterprise to address mobile application that require access to real time data. Thus, the company is operating at the intersection of two clusters: wireless and enterprise software. The example of Epic Data reinforces the idea that the presence of two industry clusters in a single geographical area creates unique opportunities for companies to differentiate themselves and create innovative product offerings.

4.6.4 Firm Strategies

The analysis of these sample firms reveals common themes with regards to company strategy. These firms rely heavily on customers and demand located outside the Vancouver area, mostly in the US. Their competitive advantage is founded on technology innovation and the availability of economically advantageous factor conditions in the Vancouver area. Both Epic Data and Spectrum Signal Processing enter the market with focused niche market strategies. Sierra Wireless adopts a differentiation strategy that is sustained through innovation and establishing a network of business relationships.

Faced with stagnant sales, Epic Data cut its R&D budget and started focusing on developing a base of local customers for its new product line. While Sierra Wireless, experiencing substantial success and growth, started developing a network of local partners and suppliers along its value chain to further enhance its position. It is also showing potential for becoming an anchor to the Vancouver wireless cluster. These are examples of the benefits derived, both in good and bad times, from belonging to an industry cluster.
4.7 Vancouver Wireless Telecommunication Cluster Characteristics Summary

At the beginning of this project, the presence of a wireless industry cluster in the Vancouver area was assumed. In accordance to the definition of a cluster, being “a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities,” the evidence presented in this chapter positively confirms the original assumption. Furthermore, the cluster continues growing and developing well beyond the emergence phase. The cluster is home-grown and its history goes back three decades in time. It survived losing its three anchor companies and weathered through the “technology bubble burst” that had severely impacted the telecommunication field.

The Vancouver region’s most important benefits with regards to the wireless industry lay in factor conditions. However its differentiating and unique characteristics are derived from the presence of related industries. The basis for factor conditions are the prosperous academic, research and innovation environments, the substantial pool of technologically talented and savvy workforce that has the advantage of being economical compared to other locations in the US and even in Canada, the ability of the region not only to retain but also to attract people with talents and skills, the advantageous public policies at various levels of government that both encourage R&D and innovation, and provide advantageous taxation and investment incentives. The only drawbacks to factors’ availability are the limited scale and sophistication of local financial investment organizations. The wireless telecommunications related and supporting industries that are well developed in the region include electronic chip design, telecommunication equipment development, enterprise software and new media. The interaction and the synergies among these industries provide a fertile ground for producing innovation and competitive solutions and products. The combinations of these conditions present many opportunities for both internally expanding the local industry and attracting investment from other regions.

The nature of demand, and the internal structure and dynamics, pose challenges to the Vancouver wireless cluster. The local demand for wireless related products and services in general lacks the sophistication and scale necessary to provide a global competitive edge for the local wireless companies. With regards to structure, the local industry is fragmented in terms of specialization, which is also reflected in having only discrete parts of the industry value chains located in the region. The cluster appears to lack a solid core and competency. Instead, three or four horizontal concentration poles are emerging at the periphery of the wireless cluster especially at the intersections with other related local industry clusters. Moreover, very few of the local companies produce consumer goods. In fact, the majority of them, which are...
predominantly small and private, tend to focus on very narrow business-to-business (B2B) relationships, especially with US counterparts. This also reveals a one-dimensional focus on technological expertise and ingenuity, but also indicates limited business management resourcefulness and notably a lack of marketing and sale management vigour. Furthermore, the cluster is vulnerable by relying on a single foreign market and not following the wireless industry’s trend of leadership slowly relocating to Asia and Europe. Concerning the cluster dynamics, the patterns of internal cooperation and rivalry between firms have been limited and until recently have been unstructured. There is evidence of various initiatives, which need further coordination and enhancement, to increase firms’ cooperation and knowledge spillovers.

Still, the Vancouver wireless telecommunication cluster continues to develop and thrive. In fact, there are 30% more companies in the cluster compared to three years ago. The participants in the Vancouver wireless industry are becoming more and more self-aware of the cluster presence and are adopting corresponding steps to further harmonize its development and growth.
IMPLICATIONS AND RECOMMENDATIONS

This chapter serves to use the analysis detailed in the previous chapter to create a series of recommendations for the Vancouver wireless telecommunication cluster. These recommendations fall within three categories: Firm strategic decisions (decisions which need to be made within individual firms within the cluster), cluster management (how the cluster as a whole could improve its management), and public policy (how local policy could be enhanced to support the development of the cluster). In making recommendations at the firm, cluster and institutional level, this chapter proposes a comprehensive and synergetic approach for the cluster development.

5.1 Firm Strategic Decisions

Wireless telecommunication companies often have to compete globally. This is most definitely the case for Vancouver companies. In the ever increasingly fluid and competitive global context, companies continuously innovate to stay ahead of the competition. However, technology leadership alone does not guarantee success. It has to be coupled with a sound business strategy to sustain a company’s growth and prosperity. In the face of globalization, the home base provides the company with the ability to innovate and differentiate itself. This section examines a few strategic actions that the Vancouver wireless companies may consider to take advantage of their home-base environment.

For established companies:

- **Further develop core competencies:** Vancouver companies are generally small in size and are faced with scarcity and limited access to capital resources. They need to learn to better leverage their assets by identifying, concentrating and further developing their core competencies, those activities that they do better than the competition. All other activities, if not critical to success of the company, may be outsourced and contracted as needed. These critical choices are not only about what a company should do but also about what it shouldn’t do. Because of proximity, cultural and environmental communalities, a local partnership and cooperation is much easier to develop, nurture and enhance. If companies outsource and contract non-essential work, they simply have more time to concentrate on what they do best.
• **Locally strengthen industry value chain**: The discussion in the previous chapter revealed that only discrete parts of the segments’ value chains are located in Vancouver. By locally encouraging the development of either supplier or customers, Vancouver wireless companies would have better influence and control over the value chain, which in turn would result in improving their performance and gaining competitive advantage.

• **Develop and join networks**: The local companies, which are small and medium in size, need to develop their ability to join forces to face larger competition. They have to become more agile and capable of changing and reconfiguring. A company’s boundaries may need to become more and more fuzzy as activities are continuously positioned and rearranged from wholly owned operations, alliances, joint ventures, subcontracts and supply agreements.

• **Pool resources for training employees**: By teaming up to organize training for their employees and further develop their skills, Vancouver companies would reduce their employee development costs and access better quality learning. For example, by organizing joint-technical and professional seminars and inviting the best experts in the field, all attendees will emerge with a higher knowledge base. Another aspect of cooperation is for companies to allow and encourage their own experts to train and mentor their peers from other organizations. This strategy also involves strengthening industry-university relationships, for example, by partnering for research, providing temporary or part time jobs to students as part of their education, creating industry specific educational programs, etc.

• **Consult each other on strategy and processes**: These actions are recommended for companies that do not directly compete with each other. The benefit for the companies is to learn from others’ experiences and share tacit knowledge. Going through this process also provides company with feedback comparable to an outside audit. This type of action presumes reaching a certain level of openness and trust.

• **Partner on specific business opportunities**: Integrating two or more companies’ skills for specific business opportunities would allow them to access and complement each other’s advantages, then potentially gain a marketing advantage and better access to new markets. The proximity of the partners allows for the establishment of more efficient relationships to take advantage of emerging opportunities.

• **Follow the local industry leader in their markets**: This strategy may be beneficial for small companies to enable efficient and economical access to new markets. Establishing new market channels is complex, onerous and time consuming; sometimes only large companies
can afford it. Targeting the same markets as the local wireless industry or related business leaders would enable easier access to their established channels and experiences.

- **Get closer to customers:** Local wireless companies may gain tremendous advantage by locating part of their activities, generally front-end or back-end activities, geographically close to their largest customer concentrations. Examples of these activities include sales functions, marketing, system design and integration, value added services, post sale support, etc. In addition to improving the customer relationship and being more attentive to their needs, this action would potentially allow the company to take advantages of the strengths of their customers’ industry cluster strengths.

For investors and entrepreneurs:

- **Scan new business opportunities for congruence with cluster strengths:** Entrepreneurs and investors contemplating new business opportunities in Vancouver would have more chance of success if the business advantages relied on more than just the advantages of factor conditions. Business opportunities that can satisfy sophisticated local demand or necessitate the combination of multiple disciplines that are locally strong would provide more solid foundation for later global competition and differentiation.

- **Adopt upfront sound strategy and business management:** Technological innovation may be what enables a company to enter a market, but good strategy and rigorous execution is what enables it to self-sustain, creating value and reaping the benefits. Entrepreneurs ought to have a larger planning scope that extends beyond proving that the idea is marketable to include strategies about sustaining and growing the business and reaping the expected benefits.

### 5.2 Cluster Management

As a group, the local Vancouver wireless telecommunication industry may benefit from the following activities:

- **Develop a shared vision for the cluster:** This starts with first determining the existing sources of the region’s competitive advantages. The next step is identifying the shared values of the participants in the industry. Then the focus should move towards creating a cluster vision.

- **Cluster management:** An entity has to be created, or alternatively a few people have to be authorized, to act as the cluster driver. This entity, or group of people, has to create opportunities and events for improving the interaction and networking activities between the local firms. In Vancouver this has already taken place with the creation of the Wireless Innovation Network of BC organization.
Marketing the cluster: This is an important communication activity that has both internal and
e external components. On the one hand, marketing the cluster internally within the industry
facilitates bringing the participants together and develops a shared identity. Additionally, it
increases the participants’ awareness of each other and stimulates a healthy local rivalry. On
the other hand, marketing the cluster externally helps attract investors, entrepreneurs, skilled
workers, and multinational companies to the region, resulting in further development of the
cluster. It also enhances the individual companies’ branding activities.

Developing the cluster: The cluster management entity can further play an important role in
facilitating the exchange between the participants and spearhead collaborative programs that
would benefit a large number of local companies. Such activities include, for example,
organizing seminars or administering funds for innovation or university research. Over the
long range, this entity can also enhance the corporate compatibilities, and harmonize and
upgrade the managerial techniques of the local companies. The development of such
 corporate culture would benefit the companies directly, and also enable them to easily create
business relationships and partnerships.

5.3 Public Policy

The role of public policy should be to create and maintain internally market-based
business environment and to overcome obstacles for free trade. Directly funding or subsidizing
an entire industry or company grouping, especially in the technology sector, has medium-term
negative effects, as the protected firms do not develop a sustainable competitive advantage.
There are few policies impacting the wireless telecommunication industry alone. Overall the
public policies aimed at enhancing the business environment in general and the high technology
sector in particular would benefit the wireless companies regardless of their location within
Canada. The most important public policy actions that would benefit the Vancouver wireless
cluster include:

• Liberalization and breaking monopolies in the telecommunication market: This should
happen in order to improve competition that would drive high quality services and affordable
prices, which in turn will create demand.

• Making more wireless spectrum available and affordable: Lowering the spectrum licensing
fees and making more bands available would create lower consumer service charges and
enable the development of newer applications that require more data bandwidth.
- **Further support research and innovation**: More funding for universities and advanced centres would benefit the local wireless companies that derive from and draw on their strengths.

- **Support exporting**: The majority of Vancouver wireless companies are exported. Removing trade barriers and lowering the export risks would positively help the local companies, especially if they go after Asian and developing countries’ markets.

- **Further enhancing copyrights and patents protection both domestically and globally**: Many of the firms in Vancouver are engaged in developing content for wireless devices. This measure will enhance their ability to innovate and produce. Content development is further enhanced by the presence in the region of a strong new media cluster, cosmopolitan culture, high tolerance and cultural diversity.

- **Enable networking and partnerships opportunities**: The various levels of government may help the sector by sponsoring and organizing opportunities for firms to showcase their products and providing forums for networking and exchange.

### 5.4 Further Research

The implementation of the recommendations in this chapter will strengthen the Vancouver wireless cluster and enhance its ability to grow and develop. Ultimately this will translate into sharpening the competitive edge of the local companies. It will also better position them on the global stage. The necessary actions involve improving strategies and management processes, adopting a system view taking in consideration the local environment and enhancing collaboration within the cluster.

The methodology adopted in this project is by no means unique to the Vancouver wireless cluster. It could be used for studying other clusters from other industries. It pre-supposes the existence of a cluster and proceeds with a top–down approach to determine its characteristics, structure and dynamics, combining available quantitative and qualitative data. This approach has inherently some caveats stemming from being considerably based on secondary data and from subjectivity caused by restricted information.

Further research may need to focus on investigating specific issues, which may need to be eventually based on primary research. A better understanding of the particular knowledge spillovers mechanisms, organizational learning methods, informal network operations, and cooperation and rivalry patterns, would further enhance the development of the Vancouver wireless cluster.
REFERENCES


Frighetto L. (2001). *The B.C. biotechnology industry: a cluster analysis*, MBA project. Faculty of Business Administration, Simon Fraser University, Vancouver, BC


APPENDIX 1 - KEY GLOBAL INDICATORS FOR THE WORLD

TELECOMMUNICATION SERVICE SECTOR

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Note: 2002 data were estimated while 2003 were forecasted.

APPENDIX 2 - VANCOUVER WIRELESS CLUSTER COMPANIES AND SURVEY RESULTS

Legend

C: customer type
1 consumer
2 enterprise
3 carrier

P: product/service type
1 components
2 equipment
3 transport
4 software
5 service

T: Technology type
1 PCS
2 Fix Wireless
3 WLAN
4 PAN
5 Satellite

O: Origin
A Vancouver
C Canada
U United States
X Global

L: Legal Status
P private
S public

S: size of local wireless activity
L large >200 employees
M medium 50-200
S small 50<
<table>
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<tr>
<th>Company</th>
<th>CPTOLS</th>
<th>Website</th>
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<tr>
<td>Air Games Wireless Inc.</td>
<td>141A</td>
<td><a href="http://www.airq.com">www.airq.com</a></td>
<td>500-1155 Robson Street, Vancouver (604)408-2228</td>
<td>Air Games is global leader in publishing and distributing mobile entertainment products. Over 40 mobile operators across 5 continents have benefited by selecting Air Games products, tools, and market knowledge.</td>
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<tr>
<td>AirlQ</td>
<td>251C</td>
<td><a href="http://www.airiq.com">www.airiq.com</a></td>
<td>215-4400 Dominion St, Burnaby (604)320-2100</td>
<td>The company operates as a wireless Internet applications service provider specializing in Telematics. AirlQ's services are offered to three large commercial markets (rental vehicle, commercial transport and heavy equipment fleets) and the Consumer market. AirlQ gives vehicle owners the abilities to manage and protect their mobiles assets. AirlQ's services include: vehicle locating, boundary notification, automated inventory, maintenance reminders, security alerts, vehicle disabling, unauthorized movement alerts and many more features.</td>
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<tr>
<td>Alpha Technologies Ltd</td>
<td>321U</td>
<td><a href="http://www.alpha.com">www.alpha.com</a></td>
<td>4084 McConnell Court, Burnaby (604) 430-1476</td>
<td>Alpha Technologies is a world leading developer of broadband, data communication, AC UPS, commercial, and industrial powering systems. World leading manufacturer of power products for the Cable Television, Telephony, Wireless and AC/UPS industries.</td>
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<tr>
<td>Apex Communications</td>
<td>151A</td>
<td><a href="http://www.teemapex.net">www.teemapex.net</a></td>
<td>#101 - 13734 104 Ave., Surrey 604-583-3300</td>
<td>Vancouver's company of choice for true integration of wireless data communication products and services. Our highly trained business consultants can guide you through the process of buying any of our communications or security products and leave you feeling like a member of the Team Apex family.</td>
</tr>
<tr>
<td>Argus Technologies Ltd</td>
<td>221A</td>
<td><a href="http://www.argus.ca">www.argus.ca</a></td>
<td>5700 Sidley Street, Burnaby (604) 436-5900</td>
<td>Produces a wide range of DC power products for wireless, fiber, broadband, PCS, traditional telephony and customer premise applications.</td>
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<td>Arkon Networks</td>
<td>223A</td>
<td><a href="http://www.arkonnetworks.com">www.arkonnetworks.com</a></td>
<td>12051 Riverside Way, Richmond (604) 241-7991</td>
<td>Arkon is recognized as a worldwide leader in DECT wireless technology solutions, offering competitive designs in telephony and wireless Internet. In addition, Arkon serves as an alpha developer and an official design house to several major wireless semiconductor companies.</td>
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<tr>
<td>Bell Mobility</td>
<td>131C</td>
<td><a href="http://www.bellmobility.ca">www.bellmobility.ca</a></td>
<td>Floor 10 - 1111 W. Georgia St, Vancouver (604) 678-4226</td>
<td>Bell Mobility is Canada's leading wireless company, providing wireless communication and data services to more than 3 million Canadians.</td>
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<td>Corinex Communications</td>
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<td><a href="http://www.corinex.com">www.corinex.com</a></td>
<td>#404-999 Canada Place Vancouver (604) 692 0520</td>
<td>Corinex is a developer and manufacturer of innovative connectivity products for the expansion of the accessibility and distribution of high speed data, audio, video and voice signals to and within premises and a provider of system integration services to industries world wide. Focus on broadband solutions for the last mile and last foot service, HW and SW.</td>
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<td>Cypress Solutions</td>
<td>2 2 1 A S P</td>
<td><a href="http://www.cypress.bc.ca">www.cypress.bc.ca</a></td>
<td>399 Mountain Vancouver (604)985-2878</td>
<td>Provide wireless rugged modems with integrated GPS &amp; engineering services.</td>
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<td>Destiny Software Productions</td>
<td>3 4 1 A S S</td>
<td><a href="http://www.dsyny.com">www.dsyny.com</a></td>
<td>950 - 555 West Hastings Vancouver 604) 609-7736</td>
<td>Destiny Media Technologies, Inc. has developed a suite of enabling tools, which facilitate the distribution of digital media through the internet in either a streaming or downloadable form. Destiny has developed three major properties : 1) Clipstream: Audio and Video on Demand; 2) RadioDestiny: Live Broadcasts; and 3) MPE: Downloadable Digital Content.</td>
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<td>Digital Dispatch Systems Inc</td>
<td>2 2 1 A M S</td>
<td><a href="http://www.digital-dispatch.com">www.digital-dispatch.com</a></td>
<td>11920 Forge Place Richmond 604) 241-1441</td>
<td>Digital Dispatch Systems is a provider of turnkey wireless mobile data systems (based automated dispatch systems and vehicle location systems) for the taxi, courier, shuttle, vehicle tracking, and airport asset management industries worldwide.</td>
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<td>Digital Payment Technologies</td>
<td>2 4 1 A S P</td>
<td><a href="http://www.digitalpaytech.com">www.digitalpaytech.com</a></td>
<td>4105 Grandview Highway Burnaby (604) 688-1959</td>
<td>DPT designs, develops and produces leading edge technology applications for the global parking industry, including advanced Equipment, Software and Solutions to manage revenue from customer payment through to bank deposit. DPT is presently the only company in the parking industry to now offer download/upload capabilities via the cost effective, compact Palm Pilot.</td>
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<td>Dyaptive Systems Inc</td>
<td>3 2 1 A S P</td>
<td><a href="http://www.dyaptive.com">www.dyaptive.com</a></td>
<td>1000-1075 W. Georgia St. Vancouver (604) 692-0778</td>
<td>Dyaptive Systems develops and manufactures equipment that enables the profitable deployment and operation of wireless networks through performance testing and optimization. Dyaptive currently has equipment installed with top-tier wireless infrastructure equipment manufacturers and wireless service providers.</td>
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<td>Empower Technologies Inc.</td>
<td>1 4 3 J S P</td>
<td><a href="http://www.linuxda.com">www.linuxda.com</a></td>
<td>120-13551 Verdun Place Richmond (604) 278-3100</td>
<td>Linux based applications for wireless devices. Brings the Linux Operating System to the consumer digital appliance market. Provider of hardware and software solutions for a wide variety of embedded devices for manufacturers and marketers. Our first turn-key solution is a Linux-based Personal Digital Assistant (PDA) which enables wireless internet connection through a cellular phone.</td>
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<td>Formweb Software Inc</td>
<td>1105-1434 Burnaby St Vancouver 1-(866)-FORMWEB</td>
<td>Formweb Platform is an integrated visual development solution for: web applications (HTML), wireless applications (WAP), and voice applications (VoiceXML).</td>
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<tr>
<td>tSONA Communications</td>
<td>140-11120 Horseshoe Way Richmond (604) 273-6333</td>
<td>tSONA has developed a series of low-cost, high-performance wireless products for telecommunications and data networking service providers; mainly, high capacity, optical wireless telecom products.</td>
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<td>Glentel Inc</td>
<td>8501 Commerce Court Burnaby (604) 415-6500</td>
<td>Glentel Inc. runs two successful businesses, WirelessWave – a chain of wireless retail stores and the Wireless Business group – a wireless systems integration company designing and commissioning wireless networks for industrial applications. Operating its fixed and mobile satellite communication, two-way dispatch and paging networks, Glentel provides North America-wide wireless data and voice solutions.</td>
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<tr>
<td>GPS Industries, Inc.</td>
<td>214-5500 152nd Street Surrey (604) 576-7442</td>
<td>GPS Industries Inc. (GPSI) is a developer and provider of GPS-based sports intelligence and information management systems utilizing the company unique, patented technology. The company &quot;Informer&quot; system was designed specifically to meet the needs of golfers, golf courses and golf course management companies The Informer combines the very latest in unique high-speed wireless technology, differential global positioning location-based services, Internet protocols, two-way messaging, media management and customer relationship management systems. GPSI was the first company to introduce a hand-held GPS golf unit and remains the only company to allow courses to mix-and-match between cart-mounted and handheld units.</td>
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<tr>
<td>Inception Software Technology Inc.</td>
<td>11928 Sunwood Place Vancouver (604) 618-7321</td>
<td>Provide a total solution of project-based services to meet your development resource needs. At Inception our greatest asset is our knowledge of wireless data technology. We have a proven track record in developing and delivering innovative leading edge solutions. We know the Software product development business and have the expertise to make your project successful.</td>
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<td>Incognito Software Inc.</td>
<td>1128 Hornby Street, 3rd Floor Vancouver (604) 688-4332</td>
<td>Incognito Software, Inc. is a rapidly growing independent company uniquely focused on developing IP, DNS, and device provisioning solutions for enterprises and broadband service providers. Founded in 1992 to provide open, standards-based networking solutions for large enterprises and government agencies, Incognito also delivers secure, scalable, and fault-tolerant software to ISPs, cable, satellite and telecom operators worldwide.</td>
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<td>Infowave Software Inc.</td>
<td>4664 Lougheed Hwy, Suite 200, Burnaby (604) 473-3600</td>
<td>Infowave’s Wireless Business Engine is a smart, flexible software that keeps you connected - wirelessly - to your corporate email, calendar, contacts, intranet, Web enabled applications, and the Internet on laptops, PDAs, or cell phones.</td>
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<td>Intrinsyc Software Inc.</td>
<td>700 W. Pender St. - 10th Floor Vancouver (604) 801-6461</td>
<td>Intrinsyc provides an integrated framework of embedded hardware, software and service solutions for creating, linking and managing Internet Devices, Information Appliances and Intelligent Devices.</td>
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<td>Ionocom</td>
<td>113-1861 Welch St, North Vancouver (604) 924 5184</td>
<td>Specializes in RF based projects, and our team has extensive experience from HF to UHF. Ionocom’s capabilities also include analog and baseband, digital logic, embedded processors and firmware. Other services include upgrade, enhancement and maintenance work on existing designs; designing sub-systems in a larger project as part of your team; and working on specific issues, for example modifying existing designs to obtain regulatory approvals. Ionocom enjoys the benefits of the strong local high-tech electronics, software and internet environment.</td>
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<td>JohnSoft Systems Inc.</td>
<td>#105 - 1273 Howe St. Vancouver 604 685 9799</td>
<td>The market of Small and Medium Enterprises (SMEs) in Canada, U.S. and China. Developed on the Windows Pocket PC platform, our Web based wireless software is mainly focused on the areas of Sales Force Automation (SFA) and Field Service Automation (FSA) for companies with a mobile workforce across various industries. Mobile professionals can submit and access information on the CRM, ERP or other back-end systems through their handheld devices equipped with GPRS, CDMA or WiFi connectivity. As a result, companies become more effective in closing deals and delivering timely service to their customers.</td>
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<td>Kinetix Wireless</td>
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<td>L3 Technology, Inc.</td>
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<td>M83 Technologies Inc.</td>
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<td>MacDonald, Dettwiler and Associates Ltd (MDA)</td>
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<td>MDSI Mobile Data Solutions Inc</td>
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<td>Company</td>
<td>CPIT</td>
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<td>Metasoft Systems Inc.</td>
<td>2 4 1</td>
<td>AS P</td>
<td><a href="http://www.meta-soft.com">www.meta-soft.com</a></td>
<td>203, 1080 Howe St. Vancouver (604) 683-6711</td>
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<td>Microcell Communications</td>
<td>1 3 1</td>
<td>CL S</td>
<td><a href="http://www.microcell.ca">www.microcell.ca</a></td>
<td>540 - 815 W. Hastings Vancouver (604) 669-1277</td>
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<td>Microsage Wireless Inc.</td>
<td>2 4 3</td>
<td>ASP</td>
<td><a href="http://www.microsagewl.com">www.microsagewl.com</a></td>
<td>1368-13351 Commerce Pkwy Richmond (604) 214-8575</td>
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<tr>
<td>Mobile Operandi</td>
<td>1 5 1</td>
<td>AS P</td>
<td><a href="http://www.mobileoperandi.com">www.mobileoperandi.com</a></td>
<td>#208, 1040 Hamilton St. Vancouver 604 6882448</td>
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<tr>
<td>netLok8 Inc.</td>
<td>1 5 1</td>
<td>AS P</td>
<td><a href="http://www.netlok8.com">www.netlok8.com</a></td>
<td>37 -1015 Ironwork Passage Vancouver (604)716-8784</td>
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<td>Norsat International Inc</td>
<td>2 2 5</td>
<td>AM S</td>
<td><a href="http://www.norsat.com">www.norsat.com</a></td>
<td>100-4401 Stil Creek Drive Burnaby (604) 292-9000</td>
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<td>Company</td>
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<td>North Beach Software</td>
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<td><a href="http://www.northbeachsoftware.com">www.northbeachsoftware.com</a></td>
<td>631-6200 McKay Avenue Burnaby</td>
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<td>OMNEX Control Systems Inc</td>
<td>2</td>
<td>A</td>
<td><a href="http://www.omnexcontrols.com">www.omnexcontrols.com</a></td>
<td>74-1833 Coast Meridian Rd. Port Coquitlam (604) 944-9247</td>
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<td>Orcatron Communications Ltd.</td>
<td>2</td>
<td>A</td>
<td><a href="http://www.orcatron.com">www.orcatron.com</a></td>
<td>1555 Kebet Way Port Coquitlam (604) 941-7909</td>
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<tr>
<td>PageNet</td>
<td>2</td>
<td>C</td>
<td><a href="http://www.pagenet.ca">www.pagenet.ca</a></td>
<td>2698 Nootka Street Vancouver (604) 254-7880</td>
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<td>PMC Sierra Inc</td>
<td>3</td>
<td>A</td>
<td><a href="http://www.pmcsierra.com">www.pmcsierra.com</a></td>
<td>105-8555 Baxter, Burnaby (604) 415-6000</td>
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<td>Qdesign Corp</td>
<td>2</td>
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<td><a href="http://www.qdesign.com">www.qdesign.com</a></td>
<td>4035 Cambie St Vancouver (604) 688-1525</td>
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<td>Rogers AT&amp;T Wireless</td>
<td>3</td>
<td>C</td>
<td><a href="http://www.rogers.com">www.rogers.com</a></td>
<td>4710 Kingsway Suite 1600 Vancouver (604) 431-1400</td>
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<td>Scion Communications</td>
<td>2</td>
<td>A</td>
<td><a href="http://www.scioncommunications.com">www.scioncommunications.com</a></td>
<td>111 Water Street, Suite 100</td>
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<td>Sendum</td>
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<td><a href="http://www.sendum.com">www.sendum.com</a></td>
<td>4500 Beedie Street</td>
<td>Sendum designs and manufactures wireless location devices.</td>
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<td>Sierra Wireless</td>
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<td>S</td>
<td><a href="http://www.sierrawireless.com">www.sierrawireless.com</a></td>
<td>13811 Wireless Richmond</td>
<td>Develops and markets a broad range of wireless data modems, PC cards,</td>
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<td>(604) 231-1100</td>
<td>and enabling software for use with handheld computing devices, notebook</td>
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<td>computers and vehicle-based or monitoring applications.</td>
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<td>Silicon Chalk</td>
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<td>S</td>
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<td><a href="http://www.silicon-chalk.com">www.silicon-chalk.com</a></td>
<td>200 - 1636 West 2nd Avenue</td>
<td>Silicon Chalk creates software to enhance communication, collaboration</td>
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<td>Vancouver (604) 732-5660</td>
<td>and learning in classrooms where laptops or other computers are employed</td>
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<td>by instructors and students. Using wirelessly communicating notebook</td>
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<td>computers within a class or lecture setting, the final version of the</td>
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<td>software will include features designed to help improve collaboration and</td>
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<td>build a learning community.</td>
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<td>SilverTip Marine Inc.</td>
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<td>S</td>
<td></td>
<td><a href="http://www.silvertipmarine.com">www.silvertipmarine.com</a></td>
<td>923 West 20th Ave</td>
<td>SmarTire Systems Inc. develops and markets proprietary tire monitoring</td>
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<td>Vancouver (604) 676-0304</td>
<td>systems for the transportation industry worldwide.</td>
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<td>SmarTire Systems Inc.</td>
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<td><a href="http://www.smartire.com">www.smartire.com</a></td>
<td>150 - 13151 Vanier Place</td>
<td>SmarTire Systems Inc. develops and markets proprietary tire monitoring</td>
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<td></td>
<td>Richmond (604) 276-9884</td>
<td>systems for the transportation industry worldwide.</td>
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<td>SMSActive</td>
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<td>S</td>
<td><a href="http://www.smsactive.com">www.smsactive.com</a></td>
<td>789 West Pender St.</td>
<td>SMS@ctive develops wireless applications that provide SMS (Short</td>
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<td>Vancouver (604) 687-7472</td>
<td>Messaging Services) based value-added Services to mobile phone users.</td>
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<td>SMS@ctive has spent the early part of its organizational existence</td>
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<td>building and developing a powerful and dynamic platform based on current</td>
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<td>SMS, WAP and other emerging wireless protocols.</td>
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<td>Soft Tracks Enterprises</td>
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<td><a href="http://www.softtracks.com">www.softtracks.com</a></td>
<td>1258-13351 CommercePkwy</td>
<td>Soft Tracks is a leading provider of innovative wireless payment solutions.</td>
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<td>Richmond (604) 214-6641</td>
<td>Strategic industry partners license Soft Tracks' open payment architecture</td>
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<td>Skype to provide secure and reliable payment acceptance in mobile and</td>
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<td>wired environments, using any form of tender, via any device.</td>
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<td>Spectrum Signal Processing Inc.</td>
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<td><a href="http://www.spectrumsignal.com">www.spectrumsignal.com</a></td>
<td>200 - 2700 Production Way</td>
<td>Develop processing elements for satellite and military wireless telecom</td>
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<td>Burnaby (604) 421-5422</td>
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<td>Tantalus Systems Corp.</td>
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<td><a href="http://www.tantalus-systems.com">www.tantalus-systems.com</a></td>
<td>4224 Manor Street</td>
<td>Tantalus designs and manufactures narrowband two-way wireless</td>
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<td>Burnaby (604) 299-0458</td>
<td>telemetry products for the utility industry. Our networks change the</td>
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<td>economics of conventional automation.</td>
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<td>Techno Systems Inc.</td>
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<td>A</td>
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<td>P</td>
<td><a href="http://www.technos.com">www.technos.com</a></td>
<td>302 - 788 Beatty Street</td>
<td>Develops mobile computing software for the collection of structured data.</td>
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<td>Vancouver (604) 435-6007</td>
<td>The leader in the field we call MCAPI Mobile Computer-Assisted Personal</td>
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<td>Interviewing, which deploys handheld computers for personal interviews.</td>
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<td>Telus Mobility</td>
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<td><a href="http://www.telusmobility.com">www.telusmobility.com</a></td>
<td>4535 Canada Way, Tower B, Burnaby (604)291-2355</td>
<td>TELUS Mobility provides its three million clients across Canada with a full suite of wireless voice, Internet and data services through its Mike and PCS digital wireless network. Telus also manage hotspots in key areas.</td>
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<td>TenDigits Software Inc.</td>
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<td><a href="http://www.tendigits.com">www.tendigits.com</a></td>
<td>850-1125 Howe Street</td>
<td>TenDigits delivers comprehensive CRM consulting &amp; customization services that streamline Sales, Marketing and Customer Service &amp; Support processes. Offer a new Software market category that we call the Mobile Information Portal (MIP).</td>
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<td>TRL Microwave Technology Inc.</td>
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<td><a href="http://www.tri-microwave.com">www.tri-microwave.com</a></td>
<td>8540 Baxter Pl Burnaby</td>
<td>TRL Microwave Technology Inc. specializes in the research, development, and manufacturing of microwave and millimeterwave products for the satellite, terrestrial and wireless communications industries. TRL is also widely recognized for its GaAs MMIC and MHMIC design capabilities. TRL is very active in the development of LMCS technology. To date, successful capability demonstrations have been performed in Brazil, Macau, Thailand and Korea.</td>
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<td>TVW Engineering</td>
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<td><a href="http://www.tvwengineering.com">www.tvwengineering.com</a></td>
<td>2901-1068 Hornby St</td>
<td>We integrate applications running on office systems or Web servers with those running on wireless devices in the field. We design wireless solutions that not only meet your needs, but also improve your productivity. Our wireless data solutions include: Database query Field service and sales force automation Messaging transactions Notification.</td>
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<td>Ucora</td>
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<td><a href="http://www.ucora.com">www.ucora.com</a></td>
<td>388-1130 W. Pender St</td>
<td>Ucora develops software tools to help businesses gain control over their data. DexObject Knowledge Engine, IntelaDex Knowledge Management System, NxtYear corporate budgeting and the ISS production scheduling system, are just a few examples of Ucora products. Ucora’s information systems operate on multiple platforms: Windows, Internet/Intranet and Wireless Networks.</td>
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<td>U-Mobile Networks Ltd.</td>
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<td><a href="http://www.u-mobile.ca">www.u-mobile.ca</a></td>
<td>#202 - 2438 Marine Dr.</td>
<td>U-Mobile Networks Ltd is a wireless Internet service provider (WISP) based in Vancouver, British Columbia. Our area of expertise includes: wireless broadband Internet setup for hotels, conference centers, small businesses, and many other publicly accessed venues; support and maintenance, networking and security. U-Mobile’s equipment and setup have been tested and are Centrino certified, giving us the absolute edge in today’s competitive market.</td>
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<td>Unity Wireless Corp.</td>
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<td><a href="http://www.unitywireless.com">www.unitywireless.com</a></td>
<td>7438 Fraser Park Drive</td>
<td>Unity Wireless produces 15 different models of High Power RF Amplifiers for both mobile and fixed wireless voice, internet and database station and repeater network equipment; Unity's proprietary UniLinx wireless IP gateways offer data communications solutions.</td>
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<td>Upside Wireless Inc.</td>
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<td><a href="http://www.upsideweb.com">www.upsideweb.com</a></td>
<td>600-515 W.Hastings St. Vancouver (604) 839-2513</td>
<td>Upside Wireless Inc. develops and markets carrier and enterprise class middleware solutions that enable development of innovative services using Small Messaging Service (SMS). Based on our base product, the Wireless Information Server, we offer three product lines: Membership Management Server with integrated marketing components for e-mail and SMS campaigns, Enterprise SMS Server that enables integration of corporate applications such as Microsoft Exchange, Microsoft Outlook, SAP and Siebel CRM with SMS networks and Carrier SMS Server that is used to provide international SMS messaging with integrated e-commerce and payment engines. One of such applications is available at <a href="http://www.ipipi.com">www.ipipi.com</a> and currently serves over 100,000 users worldwide.</td>
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<td>UTStracom ex-TELOS Technology</td>
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<td><a href="http://www.telostechnology.com">www.telostechnology.com</a></td>
<td>110 - 13120 Vanier Place Richmond (604) 276-0055</td>
<td>Carrier-class wireless Sonata product family includes MSCs, softswitches, HLRs, and authentications centers, designed for 2G, 2.5G GMS, DAMPS, CDMA and 3G. From very small systems suitable for wireless office and campus applications to the very large integrated networks for urban centers. Enabling operators worldwide to transition to next-generation wireless networks. Leading the way in 3G.</td>
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<td>Veriteq Instruments</td>
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<td><a href="http://www.veriteq.com">www.veriteq.com</a></td>
<td>110-13799 Commerce Parkway Richmond (604) 273-6850</td>
<td>Veriteq is the leader in compact precision data loggers for relative humidity, temperature, thermocouples, voltage and current. Advanced data acquisition instruments, Veriteq loggers combine high-accuracy performance with palm-sized, portable, wireless (sing a Palm PDA) and battery-operated simplicity.</td>
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<td>Verrus Mobile Technology</td>
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<td><a href="http://www.verrus.com">www.verrus.com</a></td>
<td>201-910 Richards St. Vancouver (604) 642-4286</td>
<td>Verrus Wireless offers wireless pay parking and wireless sports. Verrus allows one to pay for parking using any mobile phone or PDA. SAFECO Field is deploying Verrus Sports Services for real-time, interactive games and the ability to order food and drinks.</td>
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<td>Vaxis Mobile Solutions Inc.</td>
<td>604-630 West Georgia St, Vancouver</td>
<td><a href="http://www.vaxis.com">www.vaxis.com</a></td>
<td>Vaxis is a leading software developer of Location Services. Vaxis suite of location-based applications and platform products enable the deployment of intelligent and revenue-generating solutions for the wireless network operators, enterprises and voice portals.</td>
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<td>Vaxis Technologies</td>
<td>1310 Kootenay Street, Vancouver</td>
<td><a href="http://www.voxaura.com">www.voxaura.com</a></td>
<td>Vaxis offers a comprehensive suite of services designed specifically to handle the essential daily support needs of wireless service providers. We have extensive expertise in supporting multiple customer types of both authenticated and unauthenticated 802.11b and 802.11g networks.</td>
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<td>Voyus</td>
<td>320-3602 Canada Way, Burnaby</td>
<td><a href="http://www.voyus.com">www.voyus.com</a></td>
<td>Voyus offers a comprehensive suite of services designed specifically to handle the essential daily support needs of wireless service providers. We have extensive expertise in supporting multiple customer types of both authenticated and unauthenticated 802.11b and 802.11g networks.</td>
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<td>Wavemakers Inc</td>
<td>404-134, Abbott Street, Vancouver</td>
<td><a href="http://www.wavemakers.com">www.wavemakers.com</a></td>
<td>Wavemakers develops voice optimization software, including noise and echo cancellation, which enhances and reconstructs speech to improve the accuracy of voice user interfaces driving automotive speech applications and significantly improves the quality of voice for phone communications.</td>
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<td>WebTech Wireless Inc</td>
<td>215-4299 Canada Way, Burnaby</td>
<td><a href="http://www.webtechwireless.com">www.webtechwireless.com</a></td>
<td>WebTech has developed and manufactured a Vehicle Location System that integrates GPS, wireless technologies and the Internet to deliver wireless vehicle tracking and location services.</td>
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<td>Xybec Solutions Inc.</td>
<td><a href="http://www.xybec.com">www.xybec.com</a></td>
<td>17-1551 Johnston Street, Vancouver 604-878-9988</td>
<td>Xybec provides centrally-managed client software that gives users reliable and secure Internet access through wireless wide area and public/private WiFi networks.</td>
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<td>ZooLink Communications Ltd.</td>
<td><a href="http://www.zoolink.com">www.zoolink.com</a></td>
<td>1800-1055 W. Hastings St, Vancouver (604)638-5467</td>
<td>ZooLink is a leading developer of next generation Intelligent Internet Data Centers. Our Data Centers serve as platforms to provide co-location services to companies with mission critical Internet infrastructure. Our services are also ideal for Web-centric businesses, such as Internet Service Providers (ISPs), Applications Service Providers (ASPs), Content Providers and Carriers.</td>
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